AFRICA-*ai*- JAPAN Project (Phase 2):
African Union -*african innovation* - JKUAT AND PAUSTI Network Project

Towards Enhancement of JKUAT-PAUSTI Research and Innovation Capacity

Abstracts of Scientific Publications: 2023-2024

April 2024

Preface

The AFRICA-*ai*-JAPAN Project Phase II, is a five-year extension of the Project Phase I, an initiative of JICA-JKUAT collaboration to enhance the University's capacity for supporting PAUSTI, started in 2014.

The Project operates through four sub taskforces which include: (1) Innovation and Prototyping Integrated Centre (iPIC) which has the key objective of employing modern technologies in developing African indigenous knowledge into products and services that enhance science, engineering and technology education. The iPIC thematic areas are environment and infrastructure solutions, sustainable transport vehicles and systems, agricultural and industrial machinery and processes; (2) the Innovation Centre for Bio-resources (iCB) which has the objective to apply modern technologies to enhance the utilization of endogenous bio-resources to reduce or eliminate food and nutrition insecurity by applying climate smart approaches. The iCB thematic areas are Crop Science and Production, Animal Health and Production, Postharvest handling and Value Addition, Bio-diversity and Conservation, and Smart Waste Management; (3) Innovation Centre for Molecular Biology and Biotechnology (iCMoB) with an objective to foster understanding the molecular basis of biological activity in organisms to enhance the development of innovative solutions to meet human needs. Its thematic areas are Drug and Disease Control, Biodiversity and Conservation, Food Security and Value addition; and (4) Innovation Centre for Computing and Technological Solutions (iCCATS), which has the objective of the application of open data and analytics in enhancing research and its dissemination. The iCCATS subtaskforce started with development of a centralized computer centre which would act as the central backbone serving the entire university with all the ICT requirements. It is through these subtaskforces that the AFRICA-*ai*-JAPAN Project works to deliver a number of outputs as described in the Project Design Matrix document.

The first output includes strengthening the human capacity of JKUAT through long term (PhD and MSc) and Short term (Technical, education trips) trainings for JKUAT staff and students. It also extends to creation of a favourable environment for research through provision of state of art equipment for research, and repair and maintenance of existing infrastructure and equipment. It is foreseen that the outcome of this, will be a stable foundation for JKUAT to deliver on its PAUSTI mandate and to drive Scientific and Technological Innovations (STI) in Africa.

The second output is strengthening research in STI by providing funding support for new research and innovation projects undertaken by both postgraduate students and academic staff of JKUAT/PAUSTI. It is anticipated that this will open the door for more multidisciplinary research projects in the areas of agriculture, engineering, health and ICT, among others. The supported projects are aligned to the national development agenda (Vision 2030 and the Big Four) as well as Sustainable Development Goals of the United Nations.

The third output is development of a close academia-industry linkage necessary for sustainable technology transfer and commercialization of research and innovation outputs. The activities relating to this output include hosting of seminars on topical issues covering the thematic areas of

the project. The topics covered include concepts on innovation, building of innovation culture, role of science, technology and innovation as drivers of African transformation and development, the emergence of FabLab concept in Africa and its contribution to development, experiences and challenges in the manufacturing research arena, and the importance of continuous monitoring and evaluation of the project progress. It is anticipated that for JKUAT to remain relevant to societal needs, it needs to work closely with industry in providing scientific and technological solutions to existing problems.

The fourth output is the formation of global partnership to strengthen research collaborations with teaching and research institutions worldwide. These activities will enable JKUAT to bench mark with other institutions with a similar goal while sharing experiences and best practices with local, regional, continental and global partners. A special focus is given to capacity building and collaboration with African institutions as well as sharing development experience with ASEAN, Japanese, European and American institutions, among others. This is considered the lever that will support improvement in JKUAT human capital, research, and increased visibility through stronger outreach activities that have societal impact.

As a direct result of the research and innovation environment created and arising from the activities of the AFRICA-ai-JAPAN Project Phase II, many publications in peer reviewed journals were published over the period of **April 2023 to February 2024.** A highlight of the abstracts obtained in the last one year segregated by the sub-taskforce category, the year published and the publication serial number is provided in the subsequent section. A total of **127 publications** were documented and their distribution per year is provided in Table 1.

Table 1. Summary of abstracts from AFRICA-ai-JAPAN taskforce members and JKUAT staff

Year	Task force
2024	10
2023	117
Total	**127**

Yours Sincerely,

AFRICA-ai-JAPAN Project Director   AFRICA-ai-JAPAN Project Manager

Prof. Victoria Wambui Ngumi, Ph.D., EBS.   **Prof. Robert Kinyua (PhD)**

Acknowledgement

The Project appreciates the authors of the various abstracts from JKUAT within the period 2023 to 2024 who willingly shared their outputs with the compiling team. This is considered a good gesture for building the spirit of documentation which is critical in pelting JKUAT high in university ranking. The Project further expects JKUAT researchers to keep publishing in high impact factor journals and share their peer review journal publications with JKUAT library for consolidated archiving.

It is also a reminder that the genesis of the first edition of the book of abstracts 2014-2019 for all peer review journal publication papers stemmed from the urge of providing evidence for the outcomes of the implementation of AFRICA-ai-JAPAN Projects. This additional fourth publication (2023-2024) confirms that the seed which was planted in 2018 is still growing. It is this conviction which led the Project to initiate work on collection of all peer review journal publications.

Lastly, special thanks are given to the JKUAT Management Team for providing a favorable environment towards implementation of AFRICA-ai-JAPAN Project Phase II. We treasure every single minute dedicated towards supporting the Project. Let's keep working together towards realization of the university vision through transforming the research and innovation culture of the university. It is our desire, through JKUAT management support, to keep documenting and showcasing the growth in Scientific and Technological Innovations within the University.

Yours Sincerely,

JICA Chief Advisor at JKUAT,   AFRICA-ai- JAPAN Project Chairman
Prof. Hiroshi Koaze   **Prof. Daniel Ndaka Sila**

Table of Contents:

Introduction

A summary of the abstract from the various sub-taskforce members is as indicated below for each of the teams that form the AFRICA-ai-JAPAN project.

a. Summary of Abtracts from iCB Subtaskforce

Year	No
2024	7
2023	84
Total	**91**

b. Summary of Abstracts from iPIC Subtaskforce

Year	No
2024	0
2023	21
Total	**21**

c. Summary of Abstracts from iCMoB Subtaskforce

Year	No
2024	2
2023	6
Total	**8**

d. Summary of Abstracts from iCCATS Subtaskforce

Year	No
2023	1
2022	6
Total	**7**

1.0. RESEARCH ABSTRACTS FROM AFRICA-ai-JAPAN PROJECT TASKFORCE FOR THE PERIOD APRIL 2023 – FEBRUARY 2024

1.1. Compilation of Abstracts from iCB Subtaskforce

iCB 2024-01

Impact of the temperature reconditioning of cold-stored potatoes on the color of potato chips and French fries

*Gikundi, E. N., Buzera, A., **Orina, I.**, & **Sila, D.** (2024). Foods, 13(5), 652. https://doi.org/10.3390/foods13050652*

Abstract

The effect of temperature reconditioning on cold-stored potato tubers was investigated for three popularly consumed potato varieties (Shangi, Unica, and Dutch robjin) grown in Kenya. The potatoes were stored at 4 °C for 30 days, followed by removal and storage at 22 ± 3 °C for 9 days during which changes in sugar concentration were evaluated every two days. In parallel, potato chips and French fries were processed, and their colors were determined. The results showed that sugar content decreased significantly with increasing reconditioning time. The relative decrease in fructose content was the highest ($p < 0.05$) in Dutch robjin (57.49%), followed by Shangi (49.22%) and Unica (38.18%). Glucose content decreased by 54.1% in Dutch robjin, 49.5% in Shangi, and 50.8% in Unica. The lightness (L*) of French fries and chips increased significantly ($p < 0.05$) with reconditioning time while the redness (a*) values decreased significantly ($p < 0.05$) across all varieties. The correlation between lightness and the total reducing sugar content of the potatoes was $r < -0.93$, indicating a strong negative correlation for both products. The coefficient of determination showed that the glucose content of the tubers accounted for 80.5–97.6% of the lightness of French fries and 88.4–94.2% for potato chips. The critical glucose content range for acceptable products in French fries and chips based on the color (L* and a*) values was 12–22 mg/100g and 8–14 mg/100g, respectively, for the varieties in this study.

Key Words: potato; storage; sugars; reconditioning; cold storage

iCB 2024-02

Investigating potato flour processing methods and ratios for noodle production

*Buzera, A., Gikundi, E., Kajunju, N., Ishara, J., **Orina, I.**, & **Sila, D.** (2024). Food Science & Nutrition. DOI: 10.1002/fsn3.4058*

Abstract

A partial substitution of wheat flour with potato flour processed by various procedures was used to determine an optimal potato pretreatment method for noodle process-ing. Wheat flour was substituted with 10%, 30%, and 50% potato flour. Potato flour (PF) was processed using two different methods, including freeze-drying (FD) and low-temperature blanching, then oven drying (LTB_OD). The results showed that sub-stituting wheat flour with freeze-dried (FD) flour (44.29 µm) significantly decreased the mean particle size of the blended flour, while LTB_OD flour (223.09 µm) increased the mean particle size. The pasting properties of wheat flour significantly improved when potato flour was added, with FD flour blends having the highest results. The highest dough development time

(14.46 min) was attained when LTB_OD potato flour was substituted up to 50%. The microstructure images showed a poor and discontinuous gluten framework when potato flour content reached 50%. Adding potato flour decreased noodles' brightness (L*) while increasing their yellowness (b*). Noodles made from wheat and LTB_OD flour blends resulted in the highest cooking loss. The texture properties of noodles deteriorated when potato flour content reached 30%. Substituting up to 30% with freeze-dried flour and 10% LTB_OD resulted in noodles with the highest overall liking scores. The study suggests that for optimal noodle pro-cessing, substituting wheat flour with FD potato flour is more favorable than using LTB_OD, as it improves particle size, pasting properties, and overall liking scores while minimizing adverse effects on texture and cooking loss.

Key Words: cooking properties, noodles, potato flour, processing methods, sensory analysis, texture properties

iCB 2024-03

Characterization of coconut oil (*Cocos nucifera* L.) from commonly cultivated Kenyan varieties extracted by different methods
Musyimi, S., Njoroge, D. M., **Onyango, A.** *&* **Sila, D.** *(2024). Journal of the Kenya National Commission for UNESCO 4 (1), 2958-7999.* <u>https://doi.org/10.62049/jkncu.v4i1.62</u>

Abstract
The impacts of climate change and the need for implementing adaptation and mitigation measures. The objective of this study was to characterize the effects of different extraction methods and varieties on the extraction yields and quality profile of the resultant coconut oil. Three mature coconut varieties (East Africa Tall, Tall Yellow and Dwarf) were collected and subjected to different oil extraction techniques (traditional method, modified traditional method, mechanical expression and soxhlet method). The quality characteristics of the oil were determined using established standard protocols. Soxhlet extraction exhibited the highest oil yield ranging from 45.4% to 58.4% followed by mechanical expression (39.2- 50.1%) and the least was traditional extraction method (6.3 to 10.2%) yield depending on variety. The Dwarf variety gave significantly lower yields compared to the other varieties. The quality characteristics were within codex standards except for the high levels of free fatty acid in traditionally (0.42%) and mechanically (0.33%) extracted oil. Lauric acid was the dominant fatty acid at 47.5%-53.5% followed by myristic acid at 15.3-18.5% depending on variety and the method of extraction. The % saturated fatty acid in all varieties was >90%. Unlike in previous studies, arachidic acid was present in all varieties. The study has demonstrated that extraction methods and variety influence the oil yield and quality characteristics of coconut oil.

Key Words: Oil Extraction, Coconut Varieties, Fatty Acid Composition, Quality Characteristics

iCB 2024-04

Physicochemical properties of edible cricket oils: Implications for use in pharmaceutical and food industries
Murugu, D. K., **Onyango, A. N.***, Ndiritu, A. K., Nyangena, D. N.,* **Osuga, I. M.***, Cheseto, X., Subramanian, S., Ekesi, S. & Tanga, C. M. (2024). Future Foods, 100316.* https://doi.org/10.1016/j.fufo.2024.100316

Abstract

The prevailing global market demands locally produced, sustainable oils for biomedical applications. This study focused on evaluating the quality of cricket-derived oils and meals from *Scapsipedus icipe* Hugel, Tanga, and *Gryllus bimaculatus* De Geer common delicacy in Africa, following standard methods for physicochemical properties, fatty acid composition, and phytochemicals (oxalates, phytates, tannins, and polyphenols). The cricket oils physicochemical properties aligned with Codex Alimentarius standards for edible oils, including low solidification temperature (< 2 °C), a high refractive index (1.46), and a specific gravity of 0.88. Notably, peroxide values (1.9 to 2.5 mg mEq O2/kg), acid values (1.1 to 2.2 mg KOH/g), and saponification values (234–246 mg KOH/g) all are indicative of lightness and unsaturated fatty acids. Nutritionally, cricket powder was rich in protein (56.8–56.9% -) and fat (31.7–33.5% -of dry matter), with significant amounts of essential omega-3 and omega-6 fatty acids. Predominant saturated and monounsaturated fatty acids were palmitic (23.9–31.2 mg/100 g-) and oleic acids (10.9–11.4 mg/100 g- of oil), respectively. Antioxidant values (48.0 to 65.0 mg/100 g), inferred from total polyphenols, suggests a stable oil with long shelf-life. These results highlight the promising and sustainable potential of cricket-derived oils for applications in the food and pharmaceutical industries.

Key Words: Edible insects, Cricket oil, Oil stability, shelf life Nutraceuticals, Novel food ingredients.

iCB 2024-05

Bagging prevents russeting and decreases postharvest water loss of mango fruit cv. 'Apple'

Abstract

In Kenya, the mango (*Mangifera indica* L) cultivar 'Apple' is commercially important but it often suffers excessive russeting, which both compromises its appearance and impairs its postharvest performance. Together, these effects seriously reduce its market potential. Exposure to surface moisture is implicated in russeting of cv. 'Apple' mango. The objective was to establish the effect of bagging on russeting. Developing fruit were bagged at the onset of the exponential growth phase, using brown paper bags (Blue star®). Un-bagged fruit served as controls. The brown paper bags were selected because of their high permeance to water vapor. At harvest maturity, bagged fruit were larger, less russeted and had smaller lenticels than un-bagged control fruit. Staining with aqueous acridine orange in conjunction with fluorescence microscopy revealed numerous microcracks and larger lenticels on un-bagged control fruit but these were not evident on bagged fruit. Postharvest mass loss (principally water loss) of bagged fruit was lower than of un-bagged control fruit. In the un-bagged control fruit, the skin's water permeance increased as the russeted surface area increased ($r^2 = 0.88$ **). Fruit skins were less permeable to water vapor than the brown paper bags. The brown paper bags contributed not more than 4.2 to 9.1% of the total in-series diffusion resistance of skin + bag. The masses of isolated cuticular membranes, and of dewaxed cuticular membranes, and of wax per unit surface area were higher for un-bagged control fruit than for bagged fruit. Bagged fruit were also greener and showed less blush. There was little difference in skin carotenoid content between bagged and un-bagged control fruit, but skin anthocyanin content was lower in bagged fruit. The rates of respiration and ethylene evolution of bagged fruit were lower than those of un-bagged control fruit. There were no differences between bagged and un-bagged control fruit in their

organoleptic and nutritional properties including titratable acidity, total soluble sugars, sucrose, glucose, fructose, vitamin C and calcium content. In conclusion, bagging decreased russeting and increased postharvest performance of fruit of mango cv. 'Apple'.

Key Words: Bag, Quality, Russet, Periderm, Lenticel, Cuticle, Transpiration, Permeance.

iCB 2024-06

Inhibiting post-harvest perishability of edible beetle grubs (*Oryctes* spp) by blanching and pre-treatment with sodium metabisulphite and ascorbic acid
*Maimba, Z. W., **Kinyuru, J. N.**, Wanjala, G. W., & Egonyu, J. P. (2024). LWT- Food Science and Technology, 191, 115659.*

Abstract
Although edible beetle grubs (*Oryctes* spp) are highly nutritious, post-harvest perishability limits their utilization in food processing. This study investigated the effects of blanching singly or in combination with either ascorbic acid or sodium metabisulphite or a blend of the two chemicals, on colour, microbial quality, protein quality, total phenol content and amino acid composition of the grubs after harvest. All the pretreatments effectively preserved the colour of the grubs, reduced protein oxidation and inhibited most harmful microbes to food safety limits. The treatments had insignificant effect on amino acid profiles of the larvae. Combining blanching with ascorbic acid eliminated *Staphylococcus aureus* from the larvae and outperformed the other treatments in enhancing the content of total phenols. The findings provide prospects for preservation of the edible beetle grubs using the affordable, readily available, and easy-to-apply heat and chemical pretreatments prior to processing into other palatable food products.

Key Words: Amino acid composition, Colour, Microbial loads, Phenols, Protein quality

iCB 2024-07
History of edible insects and future perspectives
***Kinyuru, J.**, Ng'ang'a, J. & Ndung'u, N. (2024). In Insects as Food and Food Ingredients (pp. 255-263). Academic Press. https://doi.org/10.1016/B978-0-323-95594-2.00004-5*

Abstract
Humans have traditionally consumed edible insects since ancient times with reports of consumption documented in ancestral and religious chronicles. The edible insect sector has however seen changes and growth over time. Scientists and industrialists have contributed to the growth basing their contribution on the reported traditional practices and uses of insects. Insects have been found to have a role as the global population grows towards the 10 billion mark by 2050 due to their ease of production and consumption. They have also been associated with environmental sustainability in the wake of climate change as well as make a significant contribution to food and nutrition security. Potential risks regarding the use of edible insects continue to be explored with global scientists not reporting significant health risks to human consumers. Of great importance is the increase in legislation supporting the edible insect sector with industries starting to take advantage of the favourable legal landscape. However, the edible insect industry remains underdeveloped; thus more support is needed to develop the value chains and upscaling for commercialization.

iCB 2023-01

Nutritional composition and anti-nutrient levels in raw and processed varieties of finger millet promoted for nutritional security

Abstract

Finger millet (FM) is rich in nutrients such as minerals, vitamins, and amino acids. However, the levels of nutrients and their bioaccessibility depend on the variety, the levels of ant nutrients, the chemical form of nutrients, and the type of processing methods used. The study determined the levels of selected nutrients, anti-nutrients, and bioaccessibility in raw and processed varieties of finger millet being developed by the Kenya Agricultural and Livestock Research Organization (KALRO) in Kenya. Raw finger millet seeds from KALRO Centers in Kenya were processed by malting for 60 hours and roasting at 110°C for 5 minutes as the optimal conditions. Levels of minerals were determined by AAS and AES, anti-nutrients by UV-visible spectrophotometer, proteins by the Pierce kit method, and vitamins by HPLC. The IE4115 and IE3779 showed the highest levels of nutrients and lowest levels of antinutrients hence preferred for processing and bioaccessibility studies. The level (mg/100 g) of selected minerals; K, Cr^{3+}, Mg, Ca, P, Fe, and Zn were found to be highest in the following varieties of the FM; IE3779 (688.519 ± 1.57), IE 4115 (1.29 ± 0.07), IE4115 (294.38 ± 1.93), IE3779 (466.67 ± 4.17), IE4115 (250.92 ± 0.33), KERICHO P (16.98 ± 0.05) and IE4115 (64.10 ± 2.35) respectively. For β-carotene, vitamin B, B2, B3, B6 and B9 the levels were highest in the following varieties of FM; KAKW3 (0.023 ± 0.02), IE4115 (14.85 ± 0.16), IE4115 (12.998 ± 0.04), IE4115 (5.843 ± 0.07), IE3779 (0.06 ± 0.04) and KAKW4 (9.832 ± 0.08). Phytates, tannins, phenols, and oxalates were found to be lowest in the following varieties: IE3779 (14.20 ± 2.90, IE4115 (27.83 ± 0.73), NKFM1 (9.69 ± 0.07) and IE4115 (0.25 ± 0.01). The highest bioaccessibility values reported for K, Mg, Ca, P, Cr^{3+}, Fe, and Zn were 89.53% (malting, IE3779), 49.28% (malting, IE4115), 60.41% (Malting, IE4115), 69.40% (malting, IE4115), 12.9% (malting, IE4115), 59.84% (malting, KAKW3) and 66.89% (roasting, IE3779) respectively (Table 8). For beta carotene, vitamin B1, B2, B3, B6 and B9 the values were 73.33% (malting, p224), 78.84% (malting, IE4115), 78.34 (malting, IE3779), 97.63% (malting, IE4115), 91.64% (malting, IE4115), and 77.52% (roasting, IE4115) (table The result on levels and bioaccessibility showed that IE4115 and IE3779 varieties were more nutritious and therefore should be promoted for nutritional security.

Key Words: Nutrients, Ant Nutrients, Finger Millet (FM), Malting, Roasting

iCB 2023-02

Unraveling the physicochemical attributes of three cricket (*Gryllus bimaculatus*)-enriched biscuit products and implications on consumers' preference and willingness to pay

Abstract

Disgust and neophobia elicited by whole insect products, has necessitated the need to mask insect-based food products. The physico-chemical parameters, sensory acceptance, and willingness to pay (WTP) for wheat biscuits supplemented with cricket powder was evaluated. The biscuits' color

intensity correlated with the cricket inclusion levels. Spread ration of cricket-enriched-biscuits increased (1.0–1.2-folds), while the hardness and fracturability decreased (1.0–1.3-folds and 1.0–1.2 folds, respectively) compared to the control biscuit. Cricket-biscuits exhibited 1.2–1.7, 1.1–3.7, 1.2–3.0 and 1.1–1.2-folds higher ($p < 0.05$) protein, ash, fiber, and fat, respectively. Ca, Fe, and Zn were 1.1–3.7, 1.1–1.2 and 1.4–4.0-folds higher, respectively, for cricket-based biscuits. Monounsaturated and polyunsaturated fatty acids proportionally increased with increasing cricket flour. On a likert scale, 71.4%, 71.9%, 38.4% and 57.5% of the caregivers and 38.6%, 58.3%, 40.0% and 34.0% for children (3–5 years) strongly preferred the color, texture, taste and aroma, respectively, of the cricket-based biscuits. Forty-seven (47%) of the caretakers were WTP a premium of 37 Kenyan shillings (0.34 USD) for cricket-based biscuits. Our findings demonstrated that integration of cricket flour into existing market-driven consumer familiar food products significantly increased acceptability and WTP, thus promising potential to contribute to improved food and nutritional security.

Key Words: Cricket meal Food Supplementation Nutritional Quality Sensory Evaluation Caregivers Children Household food security

iCB 2023-03
Phytochemical profile and antioxidant activity of various solvent extracts of two varieties of ginger and garlic
Akullo, J. O., ***Kiage-Mokua, B. N.****, Nakimbugwe, D., &* ***Kinyuru, J.*** *(2023). Heliyon, 9(8).*

Abstract

There is limited information on the phytochemical profile and antioxidant activity of ginger and garlic consumed in Uganda. This could have an impact on its widespread use and industrial application. Thus, this study was done to determine the phytochemical profile and antioxidant activity of two varieties of ginger and garlic commonly consumed in Uganda. Fresh ginger rhizomes and garlic cloves of "local" and "hybrid" varieties were acquired from a local food market, washed, grated, and extracted using acetone, ethanol, methanol, and water. Standard techniques were used to determine the phytochemical composition. Total phenolic and flavonoid content were measured using Folin-Ciocalteu and aluminium chloride assays, respectively. Antioxidant activity was determined using the 2, 2-Diphenyl-1-picryl hydrazyl (DPPH) assays. Ginger extracts exhibited significantly higher total phenolic and flavonoid content compared to garlic ($p<0.05$). The highest total phenolic and flavonoid content was in ethanol and methanol extracts of local ginger: 1968.49 and 2172.65 mg GAE/100 g; 254.24 and 184.62 mg QE/100 g, respectively. Tannins, alkaloids, saponins, and terpenoids were in varying concentrations in the extracts. Levels of Vitamin C were significantly high in aqueous extracts ($p<0.05$), 38.34 and 40.80 AAE/100 g in local and hybrid ginger; 33.65 and 35.24 mg AAE/100 g in local and hybrid garlic, respectively. The free radical scavenging activity of extracts varied depending on concentration, with a strong positive correlation between antioxidant activity and total phenolic and flavonoid content. The half maximal inhibitory concentration (IC50) ranged from 0.16 to 8.93 mg/ml in local ginger, 4.43–6.44 mg/ml in hybrid ginger, 3.93–5.64 mg/ml in local garlic, and 4.44–5.27 mg/ml in hybrid garlic. The best antioxidant activity was exhibited by ethanol extracts of the local ginger. According to the findings, the two varieties of ginger and garlic have strong antioxidant activity due to their different phytochemical compositions, which could make them useful as natural antioxidants in food and medicine applications.

iCB 2023-04

Promoting insect farming and household consumption through agricultural training and nutrition education in Africa: A study protocol for a multisite cluster-randomized controlled trial

*Alemu, M. H., Halloran, A., Olsen, S. B., Anankware, J. P., Nyeko, P., Ayieko, M., Nyakeri, E., **Kinyuru, J.**, Konyole, S., Niassy, S., Egonyu, J. P., Malinga, G. M., Ng'ang'a, J., Ng'ong'a, C. A., Okeyo, N., Debrah, S. K., Kiiru, S., Acur, A. & Roos, N. (2023). PloS one, 18(7), e0288870. https://doi.org/10.1371/journal.pone.0288870*

Abstract

Background: Edible insects are a sustainable source of high-quality animal protein. Insect farming is gaining interest globally, particularly in low-income countries, where it may provide substantial nutritional and economic benefits. To enhance insect farming practices in Africa, new farming systems are being developed. However, knowledge on how to best promote uptake of these systems is lacking. This study aims to fill this gap by investigating the effectiveness of educational interventions in promoting insect farming for household consumption in Africa.

Method: The study is designed as a multi-site randomized controlled trial to evaluate the impacts of agricultural training alone or in combination with nutrition education on the adoption of insect farming in Ghana, Kenya and Uganda. In each of the three countries, ninety-nine villages are randomly assigned to one of three arms: two intervention arms and a control arm with no interventions. Focusing on production (P), the first intervention arm covers agricultural training on insect farming combined with provision of insect production starter kits. Focusing on both production and consumption (PC), the second intervention arm involves the same intervention components as treatment P plus additional nutrition education. The impacts of the interventions are measured by comparing baseline and endline data collected one year apart. Primary outcomes are adoption of insect farming and consumption of the farmed insects.

Discussion: Understanding the drivers and impacts of novel agricultural practices is crucial for transitioning to sustainable food systems. The current project is the first to investigate how educational interventions promote insect farming for household consumption in low-income countries. The results will contribute evidence-based knowledge to support sustainable development through insect farming in Africa.

Trial registration: The protocol is registered in the American Economic Association registry for randomized control trials with registration number AEARCTR-0009996. Initial registration date: 02 September 2022, last updated 17 May 2023.

iCB 2023-05

Nutritional profile of a novel artificial diet and the effect of photoperiod on the fitness parameters of reared *Ruspolia differens*

*Fombong, F., Tanga, C., Ng'ang'a, J., **Kinyuru, J.**, & Vanden Broeck, J. (2023). Journal of Insects as Food and Feed, 1-12.*

Abstract

The tettigoniid, *Ruspolia differens*, is a widely consumed grasshopper across Sub Sahara Africa (SSA), mainly where periodic large swarms occur during the rainy months. The present wild harvesting of this grasshopper species is not sustainable and limits the yearlong presence of these delicacies. One method to circumvent this is developing mass-rearing technologies for this nocturnal and omnivorous insect within SSA. However, to mass-rear this species on a large scale, the optimal diets and light regimes need to be established. Complete nutritional profiles of edible insect diets are rare. In our study, using a newly formulated artificial diet we assessed multiple performance traits for *R. differens* reared at two light regimes. A complete dark (<1 h light, 5:95 L:D) and 50% light (~12 h light, 50:50 L:D) from newly hatched nymphs to death of the adults. Proximate composition of this novel artificial diet was carbohydrates: 53.5%, crude protein: 21.0%, ash: 7.0%, fat: 5.0%, crude fibre: 4.5%. All essential amino acids and mineral elements were also present. It took on average 8-9 moults to reach adults in the light-reared insects as opposed to 6-7 moults for those reared in the dark. Adult longevity in the dark-reared insects was also significantly longer (37±3.7 days) compared to the light-reared ones (10±3 days). These findings strongly support the nocturnal behaviour of these bush crickets and suggest rearing them in a predominantly dark environment would seem a profitable venture, as fewer energy demands in terms of lighting are required. Such a diet, when fully optimised will facilitate automation and reduce labour for feeding them in mass-rearing programs.

Key Words: edible insects, insect farming, light regimes, artificial diet

iCB 2023-06

Cannibalism among adult bush crickets (*Ruspolia differens*) when fed on different insect preys and artificial diets

Abstract

Edible bush crickets *Ruspolia differens* have received considerable interest in recent years primarily due to their widespread consumption across Sub Sahara Africa. Currently, these pseudo grasshoppers are only available in large quantities twice a year during the rainy seasons. Therefore, there is great research interest in studying their farming potential for possible mass rearing. However, due to their cannibalistic behaviours, such attempts have proven an uphill task. This study evaluated measures that may reduce cannibalism by providing alternative prey to reared *R. differens*. Ten young adults of either females or males *R. differens* were kept separately in well-aerated cages (50×50×50 cm). Then, two sets of experiment were set up as follows: in the no-choice set-up, twenty live or dead second instar (L2) larvae each of *Hermetia illucens*, *Chilo partellus*, *Bactrocera invadens,* and *Schistocerca gregaria* were administered separately to both male and female cages for six successive days. In the choice set-up, a mixture of twenty live or dead L2 larvae of the insects mentioned above was fed for twelve consecutive days. The control diets included an artificial diet only or artificial diet + corn leaves and were provided for six days consecutively to both males and females separately. In each case, the proportion of cannibalism and the possibility of hunting behaviour by *R. differens* was recorded. Cannibalism was significantly reduced in both male and female *R. differens* cages where prey was administered compared to the control diets. Besides, cannibalism was significantly reduced

in both male and female *R. differens* cages when live insect prey was provided compared to dead insect prey. There were indications of a hunting behaviour exhibited by *R. differens* as they tended to feed more on living than on dead insect prey. Our findings show that the addition of live insect prey could reduce the prevalence of cannibalism during *R. differens*, thus preventing colony collapse due to cannibalism and also providing a safe means to eliminate insect pests, which could serve as prey.

iCB 2023-07

Cardioprotective effects of insect *Apis melifera*-based complementary foods using an in vivo mouse model

Abstract

Background. Cardiovascular disease is the cause of one-third of deaths worldwide because of increased risk factors, such as intake of cholesterol and saturated fat. Atherosclerosis begins in childhood; therefore, nutritional prevention should begin at an early stage. This study assessed the lipid profile, atherogenic, and castill's risk index intake of *Apis melifera*-based complementary foods using an in vivo mouse model. *Methods*. The experiment was conducted for 28 days. A total of 75 male white albino mice were randomly assigned to five diets in triplicate. The diets were Diet 1 = casein diet; Diet 2 = (57% maize, 29% teff, 14% soybean); Diet 3 = (58% maize, 29% teff, 13% bee larvae); Diet 4 = commercial wean mix; Diet 5 = basal diet alone. Mouse blood samples were collected by cardiac puncture. The lipid profiles of TC, TG, HDL-C, and LDL-C were analysed using an automated pentra C400 made in France. *Results*. Biochemical (mg/dl) parameters showed that mice fed Diet 3 had high (≤ 0.001), TG (167.79), HDL-C (67.18), and low LDL-C (71.73) levels. The atherogenic indices CRI-I (1.84), CRI-II (1.07), and AC (0.84) were low in Diet 3. The atherogenicity indices showed a significant positive correlation (≤ 0.001) with one another as follows: CRI-I vs. CRI-II ($r = 0.919$), CRI-I vs. AC ($r = 1$), and CRI-II vs. AC ($r = 0.919$). *Conclusion*. The results of the present investigation confirm that intake of an *Apis mellifera*-based diet could prevent children from atherosclerotic cardiovascular disease in a mouse model.

iCB 2023-08

Effects of temperature variation on yield and quality of field crickets (*Gryllus bimaculatus*) and black soldier flies (*Hermetia illucens*)

Abstract

Insect rearing provides an affordable alternative source of animal nutrition for most small-scale farmers. However, current rearing technology with uncontrolled environmental conditions suppresses insect yields, leading to low adoption of insect production. The objective of this study was to assess the effect of temperature variation, using an adaptive control structure, on the yield of field crickets (*Gryllus bimaculatus*) and black soldier fly larvae (*Hermetia illucens*). Temperature values of 25°C, 27°C, and 30°C constant relative humidity of 50%, and constant air speed of 3 m/s were adopted for

the study. Throughout the study, weighing of the insect wet yield was done on a daily basis for larvae and after three days for cricket pinheads. Black soldier fly larvae and adult crickets were harvested at the ages of two weeks and six weeks, respectively, and oven dried at 105°C for 24 hours for subsequent analysis of proteins. Results indicated that black soldier fly larvae reared at 25°C, 27°C, and 30°C had a maximum mean wet yield of 0.216 ± 0.022 g, 0.234 ± 0.019 g, and 0.248 ± 0.016 g, respectively, at the age of two weeks. Similarly, crickets reared at 25°C, 27°C, and 30°C had a mean yield of 0.807 ± 0.167 g, 0.933 ± 0.102 g, and 1.306 ± 0.254 g at the age of six weeks. Dried cricket reared at 25°C, 27°C, and 30°C had 25.566 ± 0.012%, 46.811 ± 0.647%, and 58.216 ± 1.510% protein, respectively. Contrary to this, black soldier flies reared at 25°C, 27°C, and 30°C yielded 42.655 ± 1.732%, 47.121 ± 0.015%, and 62.536 ± 0.014%, respectively. Larval yield recorded significant different yields (f = 4.935, p = 0.03), whereas crickets failed to record significant different yields (f = 0.777, p = 0.388) under different temperature levels. A higher temperature regime yielded higher body mass and protein turnover. The findings of this study boost the future prospects of insects as food and feed for enhancing food and nutrition security.

Key Words: Adaptive rearing structure, Environment, Insect feed, Yield

iCB 2023-09
Potential for use of seaweed as a fish feed ingredient: a review
*Mwendwa, R., **Wawire, M.**, & **Kahenya, P.** (2023). Journal of Agricultural Science, 15(2), 10-5539. doi:10.5539/jas.v15n2p96*

Abstract
Seaweeds, also known as macroalgae are marine plants used widely as food and applied in other food allied industries, pharmaceuticals, cosmetics and agrochemical industries. Their production has increased over the years with advancement in identification and cultivation of different seaweed species. Over the years seaweeds have been explored as a food due to their nutrition value and bioactive compounds that are beneficial to human nutrition and health. With this principle, seaweeds can also be used as feed ingredient in aqua feeds especially due to the fact that it is a source of omega-3 and hence can be used as an alternative to fish oil whose supply has declined. Studies have shown that polyunsaturated fatty acids which are important in fish nutrition can account for about 50% of total fatty acids in seaweeds. In addition to being a good source of polyunsaturated fatty acids, seaweeds provide protein and minerals, vitamins. They are also characterized with high levels of protein rich in all the amino acids relative to some higher plant-based protein crops like soya bean. This review, therefore, aims to look at the potential of seaweed as an aqua feed ingredient with the emphasis on the nutritional characteristics.

Key Words: seaweed, nutritional, polyunsaturated fatty acids, polysaccharides, aquaculture, feeds

iCB 2023-10
Designing mobile phone text messages using the behavior change wheel framework to influence food literacy in adults with type 2 diabetes in Kenya: Protocol for a systematic development study
*Mokaya, M., **Kyallo, F.**, Yiga, P., Koole, J. L., Boedt, T., Vangoitsenhoven, R., & Matthys, C. (2023). JMIR Research Protocols, 12(1), e48271. doi: 10.2196/48271*

Abstract

Background**:** The worldwide prevalence of type 2 diabetes (T2D) has increased in the past decade, and it is projected to increase by 126% by 2045 in Africa. At the same time, mobile phone use has increased in Africa, providing a potential for innovative mobile health interventions to support diabetes care. Objective: This study aimed to apply the Behavior Change Wheel (BCW) framework to develop text messages to influence food literacy in adults with T2D in urban Kenya. Methods: The 8 steps of the BCW framework guided the development of text messages: (1) Define the problem in behavioral terms; (2) select target behaviors; (3) specify the target behaviors based on who needs to perform the behaviors, what needs to change, and when, where, how often, and with whom; (4) identify what needs to change; (5) identify intervention functions; (6) select policy categories; (7) select behavior change techniques (BCTs); and (8) select the mode of delivery. Recent exploratory studies in Kenya and other low- and middle-income countries provided information that was used to contextualize the intervention. Results: In step 1, the behavioral problem was defined as unhealthy dietary patterns among adults with T2D. In step 2, based on a qualitative study in the target population, the target behavior was selected to be evaluation of reliable sources of information, and selection and preparation of healthy food. In step 3, unhealthy dietary patterns were selected. In step 4, 10 domains of the Theoretical Domains Framework were identified, and in step 5, 5 intervention functions were linked to the domains and unhealthy dietary patterns were specified. In step 6, communication and regulations were identified as policy categories, while in step 7, 9 BCTs were selected from the Behavior Change Technique Taxonomy version 1. In step 8, the most suitable mode of delivery was determined to be mobile text messages. A total of 36 mobile text messages were developed based on the 9 BCTs. Conclusions: This study shows the step-by-step application of the BCW framework to develop mobile text messages to influence food literacy in adults with T2D.

*Key Words***:** behavior change techniques; Behavior Change Wheel; type 2 diabetes; low-income populations; mHealth; mobile   health; glycemic   control; adults; diabetes; Africa; mobile phone; support care; care; support; behavior; diabetes

iCB 2023-11

Growth performance and biochemical composition of Nile tilapia (*Oreochromis niloticus*) reared in membrane bioreactor treated wastewater

Mwendwa, R., **Wawire, M.***,* **Kahenya, P.***. & Edwin Oyoo, P. K. (2023). Journal of Agricultural Science, 15(12). doi:10.5539/jas.v15n12p61*

Abstract

The aquaculture sector in Africa has great potential for growth; however, it faces several challenges, one of them being the scarcity of clean water. This prompts the need for water recycling. The present study was conducted to investigate the effects of rearing Nile tilapia (Oreochromis niloticus) using municipal wastewater treated with membrane bioreactor (MBR) technology. A total of 270 Nile tilapia fingerlings (0.15±0.05 g) were reared in three treatment groups in triplicate. There were 2 treatments, including; MBR treated wastewater and stabilization pond treated wastewater (maturation pond), while the municipal tap water was used as the control. The growth performance (weight and length) of the fish was monitored over a 24-week period. After the experimental period, the biochemical composition of the fish muscle was analysed using standard AOAC methods. The results

showed that the highest weight gain, length gain, survival rate, and specific growth were obtained in the fish in the control followed by the MBR treatment. Additionally, the crude protein, as well as the crude fiber and dry matter, were significantly higher in the fish in the maturation ponds at 23.10%, 0.29%, and 25.35%, respectively, while the crude ash was highest in the MBR at 1.22%. Results also showed that the MBR and maturation pond treatments meet the permissible levels for BOD, COD, NH4, and NO3 for water to be used in aquaculture. The bioaccumulation of heavy metals in the fish was mainly from the feed, with copper being the highest contaminant at 1.75 mg/100 g. In conclusion, both the MBR and maturation pond treated wastewater are viable for use in the rearing of Nile tilapia without adverse effect on the growth. However, MBR treatment showed better growth performance, suggesting that it could be used to increase productivity in fish farming.

Key Words: membrane bioreactor, Nile tilapia, physiochemical, heavy metals, maturation pond

iCB 2023-12
Hypolipidaemic effects of papaya (*Carica papaya* L.) juice on rats fed on a high fat and fructose diet

Abstract
Papaya (*Carica papaya* L.) is a highly nutritious and less-caloric fruit, commonly consumed for its minerals and vitamins and hence may help in controlling obesity and abdominal discomforts. The present study investigated the hypolipidaemic effects of papaya juice extract on male Albino Wistar rats (7 weeks old; 185 ± 17 g) fed on a high fat and fructose diet (HFFD) for 6 weeks. The rats were divided into groups I–IV of five rats each and fed on either a HFFD (i.e. the Control), HFFD + 200 mg papaya, HFFD + 350 mg papaya or a HFFD + 500 mg papaya. On day 34, after an overnight fast, blood samples were obtained by cardiac puncture under 99·8 % Chloroform anaesthesia for the determination of serum triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-c) and high-density cholesterol (HDL-c). The atherogenic (AI) and coronary risk (CRI) indices were also calculated. Statistical analysis was performed using ANOVA where means were separated using Tukey's HSD test. Resulted showed that all rats given papaya juice had an increasing, non-significant HDL-c and reduced LDL-c levels while rats fed on HFFD had the highest TC (53·2 mg/dl) and TG (37·6 mg/dl) levels. Papaya juice statistically reduced the AI and CRI of the rats. In conclusion, consumption of HFFD + 500 mg was the most effective in the reduction of rats' blood lipids and fats, due to its anti-obesity and hypolipidaemic properties, thus can be used in the management of dyspilidaemic disorders.

Key Words: Blood lipids, High fat and fructose diet, Hypolipidaemic, Papaya (*Carica papaya* L.)

iCB 2023-13
Isolation, purification and biochemical characterization of alkaline α-amylase from Bacillus subtilis strain W3SFR5 isolated from kitchen Wastes

Abstract

Background and Objective: Amylase is a hydrolytic enzyme that breaks starch into simple sugars. This enzyme includes uses in starch production, brewery, detergent formulation, paper production and pharmaceuticals as a digest aid. The aim of the present study was to isolate, identify and characterize an alkaline amylase from bacteria of food wastes. *Material and Methods*: Bacteria were isolated using serial dilution, screened on agar plates and characterized through biochemical assessments and 16S rRNA sequencing. After optimizing the bacterial growth conditions using one factor at a time method, the alkaline amylase was extracted from the culture broth and partially purified using Sephadex G-75 chromatography. Enzyme activity generated by submerged fermentation was assessed using 3,5-dinitrosalicylic and recorded as the mean of three replicates. *Results and Conclusion*: The bacterial isolate W3SFR5 showed high amylolytic activity in agar culture. Biochemical analysis and sequencing of the 16S rRNA verified the bacterial isolate as *Bacillus subtilis* (GenBank accession number: OM258620). *Bacillus subtilis* W3SFR5 was propagated within 30–50 °C and pH 6-9. The partially purified *Bacillus subtilis* W3SFR5 amylase included a molecular weight of 65 kDa and demonstrated a maximum specific activity of 216.02U mg^{-1}. The optimum temperature for the enzyme was 60 °C and the pH was 9. The W3SFR5 amylase was actively stable under temperatures of 50–70 °C and pH of 7-9. Furthermore, 5 mM Fe^{2+} increased W3SFR5 amylase activity. The enzyme was more resistant to organic solvents, surfactants, inhibitors and oxidizing agents than that most amylases were. Additionally, results showed that W3SFR5 amylase was compatible with most commercial detergents, indicating that it could be used as a detergent additive.

Key Words: Bacillus subtilis, W3SFR5-amylase, Biochemical characterization, Detergent compatibility

iCB 2023-14

Distribution, transportation, and coordination in African indigenous vegetables value chains: A scoping review

Abstract

Malnutrition continues to be a major problem with negative implications on economic and human development in many parts of the world, including in Sub-Saharan Africa (SSA). Strengthening promising underutilized crops that are nutrient dense, climate resilient, and locally adaptable is an instrumental approach to enhancing dietary diversity. Due to their nutritional and economic benefits, African Indigenous Vegetables (AIVs) have the potential to contribute to livelihoods and address challenges of food and nutrition insecurity. Despite their importance but due to their perishability, AIVs tend to suffer from high post-harvest losses (PHLs). Effective distribution systems along the value chain have the potential to reduce PHLs for AIVs. We therefore conducted a scoping review on transport systems and coordination in AIVs value chains in SSA. The objectives of this review were to summarize and analyze the focus of research in AIVs transport, to analyze the extent to which the literature synthesizes interactions of sub-components of the chains, and to identify knowledge gaps in AIVs transport literature. Based on the research foci, we categorize the reviewed articles into seven

themes. Our analyses indicate that distance to agricultural market is a fundamental aspect of AIVs transportation, as it interacts with transport costs, market participation, produce quality, and profit efficiency. Results show that collective action is instrumental in the coordination of AIVs transportation and that it contributes to cost reduction. Following light exploration of determinants of choice of means of transport, we recommend further research in this area for improvement of transportation in AIVs value chains.

Key Words: transportation, AIVs, logistics, collective action, distance to market, food systems, value chain, marketing

iCB 2023-15
Effect of climate smart agriculture technologies on crop yields: Evidence from potato production in Kenya
*Andati, P., **Majiwa, E.**, Ngigi, M., **Mbeche, R.**, & **Ateka, J.** (2023). Climate Risk Management, 41, 100539.*

Abstract
Climate change is one of the current global issues of concern given that it is affecting agricultural production. Sub-Saharan Africa (SSA), which frequently experiences severe weather and natural disasters, is particularly vulnerable to climate change. Even though numerous measures are being promoted to mitigate climate change in SSA, little evidence exists regarding the adoption of climate-smart agriculture (CSA) technologies in potato farming and its effect on yield. CSA is widely acknowledged as a crucial technique for farmers to adapt to climate change and raise agricultural productivity. This study investigated the effects of CSA technology adoption among potato farmers in Kenya. A descriptive survey was adopted. A multistage sampling technique was used to randomly select 350 potato farming households in Nyandarua County. Data was collected using a questionnaire and interview techniques. Propensity Score Matching (PSM) was used to evaluate the effects of CSA technologies on potato yields. The results indicated that on average potato farmers adopted 8 out of the 18 CSA technologies. The PSM results indicated that the adoption of CSA technologies improved potato yields. Adoption of seed management technologies enhanced potato yield by 61 % followed by soil nutrient management, crop improvement practices, seed management, and crop protection techniques by 50 %, 41 %, 40 %, and 39 %, respectively. This implies that smallholder farmers' adoption of climate-smart technologies is critical for increasing and maintaining potato yield. However, adopting water management technologies like water harvesting and irrigation negatively affected potato yield. The study discusses the implications of these findings.

Key Words: Climate change, Climate-smart agriculture, Propensity score matching, Potato yield, Kenya

iCB 2023-16
Intention to adopt improved indigenous chicken breeds among smallholder farmers in Machakos County, Kenya. Do socio-psychological factors matter?
*Kamau, C. N., **Majiwa, E. B.**, **Otieno, G. O.**, & Kabuage, L. W. (2023). Heliyon, 9(11). e22381. https://doi.org/10.1016/j.heliyon.2023.e22381*

Abstract

Consumption of poultry meat, eggs, and other animal-sourced commodities has dramatically risen by almost 86 %, with the demand of indigenous chicken products almost doubling over the past few decades. In Kenya, poultry farmers prefer indigenous chicken (IC) due to their resilience to harsh climatic conditions, high feed conversion rates, delicious end products, ability to scavenge and potential to reduce greenhouse gas emissions among other factors. Despite the high demand for poultry and its products, the gap between demand and production remains high. Poultry farmers try to keep pace with the demand by integrating the recommended improved IC breeds into their production system. Although there exists some understanding on the determinants of the farmers to adopt improved IC, still there is scanty information on how socio-psychological factors influence the intention to adoption improved IC among the farmers in Kenya. Thus, this study sought to investigate the determinants of intention to adopt improved IC while specially focusing on the role of socio-psychological factors. A total of 374 IC farmers in Machakos County were selected using a multistage sampling technique. Partial Least Square - Structural Equation Modelling (PLS-SEM) was employed to analyze the data. Results from descriptive statistics showed that approximately 90 % of IC farmers in the study area were aware of the improved indigenous chicken breeds. However, the adoption of the improved IC was below average (44.9 %). The path analysis results revealed that Subjective Norm (SN) was the main determinant of farmer's intention to adopt improved IC breeds, followed by Attitude (ATT) and Perceived Behavioral Control (PBC). The study recommends more emphasis to be given to psycho-social issues through well designed public and private interventions that will promote adoption of improved breeds among IC farmers.

Key Words: Structural equation modelling, Improved indigenous chicken, Intention, Adoption, Awareness

iCB 2023-17

Impact of contract farming on the income of smallholder dairy farmers from Nyagatare district in the Eastern Province of Rwanda

Abstract

The demand for dairy milk and its products is projected to increase significantly in the developing countries by the year 2030. Globally, close to 6 billion people consume milk and other dairy products due to rising earnings, population expansion, urbanization, and dietary changes. The projected increase in demand for dairy milk and its products thus requires enhanced productivity by the dairy farmers. However, dairy farming is relatively capital intensive which requires dairy farmers to have disposal income to run the venture. Contract farming is gradually being embraced in Rwanda as a viable option to help farmers increase dairy productivity. The impact of contract farming on dairy farmers' incomes is however not well documented in the Rwandan context. Thus, the purpose of this study was to assess the impact of contract farming on smallholder dairy farmers' income in Rwanda among smallholders' dairy farmers in Nyagatare District. Following the stratification and purposive sampling of two sectors, random sampling of two villages from each of those sectors allowed for the systematic and purposive sampling of representative households and farmers. Data from 214

smallholder dairy farmers were collected using structured interviews and document reviews. The multivariate logistic analysis and propensity score matching was used for data analysis in Stata Version 15. The findings showed that smallholder dairy farmers adopting contract farming earned on average 135,000 RWF (135$) more than their non-adopter counterparts. Further, contract farming was found to have a significant positive impact on income among smallholder dairy farmers in Nyagatare district. However, the impact of contract farming on farmer incomes could be further augmented by increasing the heads of cattle owned per farmer, to at least more than 30. Government intervention is one way to achieve this. The government, in collaboration with businesses like Heifer International, can give heifers to smallscale dairy farmers.

*Key Words***:** Contract farming, Income, Smallholder dairy farmers, Impact, Rwanda

iCB 2023-18
Evidence of circular business model innovation in agribusinesses in Rwanda
Kim, S. K., Taremwa, N. K., Vasanthakaalam, H., Bayer, T., Miller, V., **Majiwa, E.***, & Macharía, I. (2023). In ISPIM Conference Proceedings (pp. 1-7). The International Society for Professional Innovation Management (ISPIM).*

Abstract
African economies are susceptible to global food market shocks and prices. Incorporating circular and regenerative strategies into domestic agricultural production and processing has been identified as a possible solution. This requires transforming linear business models into circular models. However, lessons from circular innovations are limited to examples from advanced economies focusing mainly on industrial technology. Little is known about circularity in agribusinesses in emerging economies. This research addresses this gap by assessing various circular business model innovations found in agribusinesses in Rwanda. The Rwandan government is committed to the circular economy model, and agriculture is a priority and targeted sector for the CE transition. Qualitative and quantitative data from 16 companies were collected. Initial findings indicate that examples of circular practices primarily focus on reusing, repairing, repurposing material, and regenerating soil fertility. Particular challenges are related to a lack of infrastructure, such as locally available packaging materials and machinery.

iCB 2023-19
Competitor orientation and performance of small and medium enterprises in Kenya
Sigey, R. K., Omwenga, J., & **Sije, A.** *(2023). Journal of Strategic Management, 3(4), 1-14.*

Abstract
Many countries recognize that, apart from development, SMEs play an important role in ensuring economic stability, growth, job creation, and social cohesion. Despite the importance of the SME sector in developing economies, these businesses face various challenges including a lack of working capital, diversion of income for other purposes, and personal problems. This study sought to determine the effect of competitor orientation on performance of SMEs in Kenya. The study also sought to establish the moderating role of information technology capability on competitor orientation as pertained to the performance of SMEs in Kenya. The study adopted a cross-sectional survey research design and, the targeted population was SMEs. The sample population was a census of the

top 100 Small and Medium-sized firms. Data was analyzed using descriptive and inferential statistics. The study established that the implementation of competitor orientation strategies affects the firm performance positively. Information technology capability causes a positive effect of competitor orientation on SME performance but not significant. Competitor-oriented firms are quick to develop new products and defend their product market share through adequate brand-oriented actions. The management therefore can ensure that competitor-oriented talents are nurtured in their firms.

Key Words: *Competitor orientation, information technology, performance, small and medium enterprises*

iCB 2023-20
Entrepreneurial orientation and performance of small and medium enterprises in Kenya
*Sigey, R. K., Omwenga, J., & **Sije, A.** (2023). Journal of Entrepreneurship & Project Management, 3(2), 19-35.*

Abstract

Many nations acknowledge that SMEs play an important role in ensuring economic stability, growth, job creation, and social cohesion besides development. Despite the importance of SME sector in the growing economy, these enterprises face various challenges that include a shortage of operating funds, diversion of returns to other uses, and personal issues. The objective of this study was to assess the entrepreneurial orientation and performance of SMEs in Kenya. The study also sought to determine the moderating role of information technology capability on entrepreneurial orientation as pertained the performance of SMEs in Kenya. The study was anchored on the resource-based view theory. The study adopted a cross-sectional survey research design and, the targeted population was SMEs. The sample population was a census of top 100 Small and Medium-sized firms which were surveyed by Nation Media Group and KPMG Audit and Management firm for the year 2017. Self-administered semi-structured questionnaires were used to collect primary data. Data was analyzed using descriptive and inferential statistics. The study found that SMEs' performance was influenced positively but insignificantly by entrepreneurial orientation. Results also indicated that in the presence of information technology capability, the contribution of entrepreneurial orientation towards the performance of SMEs is insignificant. The study concludes that it is important for SME firms to build entrepreneurial capacities to enhance performance. The study recommended that SME managers need to put in place resources and mechanisms that encourage and support entrepreneurial activities. Such activities such as encouraging innovation, product offering and continuously assessing risk.

Key Words: Entrepreneurial Orientation, Information Technology, Performance of Small and Medium Enterprises

iCB 2023-21
Effect of cost restructuring on performance of star rated hotels in Nairobi City County, Kenya
*Osoo, J. A., & **Sije, A.** (2023). International Academic Journal of Human Resource and Business Administration, 4(3), 231-245. https://iajournals.org/articles/iajhrba_v4_i3_231_245.pdf*

Abstract

The main objective of the study was to establish the effect of cost restructuring on performance of star rated hotels in Nairobi City County, Kenya. The study was anchored on Transaction Cost Theory, Agency Theory, Social Exchange Theory, and Planned Change Theory. A descriptive research design was employed in the study. The study targeted 44 rated hotels operating in Nairobi City County as outlined by Tourism Regulatory Authority. The Study was carried out only in 40 hotels. The unit of observation comprised of one manager, and one supervisor in the hotels making a total of 80 respondents. Primary data was collected through a five-point likert questionnaire. Both inferential and descriptive statistics were employed in analyzing the collected data. Both SPSS software and MS Excel were used in generating the statistics. The study results and findings of the analysis were presented in form of tables and figures. The study established that cost restructuring bears a positive and significant effect on performance of rated hotels operating in Nairobi City County. The study provides the recommendations to the management of the star rated hotels to enhance the levels of cost restructuring process since the practice bears a positive and significant effect on performance of the hotels.

*Key Words***:** Cost Restructuring, Performance, Star Rated Hotels, Organizational Restructuring.

iCB 2023-22

Strategic quality management practices and operational performance of soft drink manufacturing firms in Nairobi County, Kenya

*Kinyua, I. W., & **Sije, A.** (2023). International Journal of Social Sciences Management and Entrepreneurship (IJSSME), 7(1).*

Abstract

The general objective of this study was to establish the influence of strategic quality management practices on operational performance of soft drinks manufacturing firms in Nairobi County. Specifically, the study sought to measure the impact of continuous improvement on operational performance of soft drinks manufacturing firms in Nairobi County and to quantify the effect of customer management on operational performance of soft drinks manufacturing firms in Nairobi County. This study was guided by the stakeholder theory, and agency theory to explain the relationship between the study variables. The research adopted descriptive survey method. The target population included 64 soft drinks manufacturing firms listed to be operating in Nairobi County. The unit of observation were heads of operations and human resource unit of each soft drinks manufacturing firm. The total target was 128 respondents. The findings of the study indicated that continuous improvement and customer management had a positive impact on the performance of the soft drink manufacturing firms in Nairobi County, Kenya. The study recommends that firms should foster a culture of quality within the organization by involving employees at all levels in the audit process and encouraging them to take ownership of quality improvement. The targeted firms should also consider factors such as geographical location, production capabilities, and sustainability practices when selecting suppliers, as these can impact the overall efficiency and effectiveness of the supply chain. The study also recommends policies that encourage collaboration between soft drink manufacturers and other stakeholders, such as government agencies, industry associations, and research institutions, to address shared challenges and opportunities.

iCB 2023-23
Impact of agricultural credit on technical efficiency and technological gap ratio among coffee farmers in Kenya
Wanzala, R. W., Marwa, N., & Nanziri, E. (2023, June). In ICABR Conference (pp. 93-114). Cham: Springer Nature Switzerland.

Abstract

Extant literature demonstrates that the technical efficiency (TE) of coffee farmers is on a downward trajectory but there are scarce resources to link how agricultural credit is directly instrumental in improving technical efficiency. Therefore, this study was conducted in Kiambu County in Kenya to determine the impact of agricultural credit on technical efficiency and the technological gap ratio among coffee farmers. The data for the study from 2017 to 2019 was obtained from Commodity Fund and farmers' cooperative societies. The paper adopted a meta-frontier framework to estimate the technology gap ratios (TGR) for participating (PF) and non-participating (NPF) coffee farmers in the credit program. The empirical results disclose that PF and NPF adopted heterogeneous production technologies given their dissimilar access to credit that is essential for the acquisition of inputs. The TGR for PF and NPF was 0.969 and 0.747 respectively which indicate that PF operated on a loftier frontier in comparison to NPF. Thus, PF were technically efficient as compared to NPF given their very small gap between regional and meta-frontier efficiencies (MFE). The Decision-Making Unit inefficiency estimates indicate that the credit program interventions aimed at efficiency improvement in NPF should be targeted at enhancing farmers' access to optimal combinations of inputs and advisory services through extension visits. Consequently, this paper recommends policies tailor-made to promote credit access by smallholder farmers to improve TE and TGR.

iCB 2023-24
Optimized Poly (3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) Production by Moderately Haloalkaliphilic Bacterium *Halomonas alkalicola* Ext
Muigano, M. N., Anami, S. E., Onguso, J. M., & Mauti, G. O. (2024). International Journal of Polymer Science, 2024. https://doi.org/10.1155/2024/6667843

Abstract

Polyhydroxyalkanoates (PHAs) are biodegradable and biocompatible polymers that are produced by microorganisms as storage materials under limited nutrition and excess carbon. These PHAs have been found to be ideal for replacing synthetic plastics for use in packaging and biomedical applications. In this study, an alkaliphilic and moderately halophilic bacterium Halomonas alkalicola Ext was isolated from Lake Simbi Nyaima in western Kenya and investigated for PHA production. Sudan Black B and Nile Red A staining showed that bacterium had distinct ability for accumulation of PHAs. To optimize PHA production, the bacterium was grown in submerged fermentation under varying culture conditions and different sources and concentrations of carbon and nitrogen. With one-

factor-at-a-time (OFTA) approach, optimal PHA yields were obtained after 72 hours at a pH of 10.0, temperature of 35° C, and 2.5% (w/v) NaCl. The bacterium yielded the highest biomass, and PHA amounts on 2% galactose and 0.1% ammonium sulfate as sources of carbon and nitrogen, respectively. A record PHA yield of 0.071 g g-1 with a titer of 1 419 ± 0 09 g/L was achieved from 3.397 g/L of biomass, equivalent to 41.8% PHA content. Using response surface methodology, PHA titer was increased by 1.5% to 1.44 g/L, while PHA content was improved 1.1-fold to 45.57%. Polymer analysis revealed that the extracted PHA was a poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) $(3 - HB\ 3 - HV = 92\ 8)$ with two copolymer subunits of 3-hydroxyvaryrate (3-HB) and 3-hydroxybutyrate (3-HV). Halomonas alkalicola Ext attained efficient galactose conversion into PHBV under high salinity and alkalinity conditions.

iCB 2023-25
Synergistic effects of substrate inoculation with *Pseudomonas* strains on tomato phenology, yield, and selected human health-related phytochemical compounds
Issifu, M., Naitchede, L. H. S., **Ateka, E. M.**, **Onguso, J.**, *& Ngumi, V. W. (2023). Agrosystems, Geosciences & Environment, 6(4), e20435.*

Abstract

Plant growth-promoting rhizobacteria enhances nutritional availability during root colonization. *Pseudomonas* is the most popular bioinoculant due to its synergistic effects on plant development. This study evaluated the impact of four *Pseudomonas* strain substrate inoculations on tomato phenology, yield, and selected phytochemical components relevant to human health. The bacterial isolates have been characterized morphologically, biochemically, physiologically, and phylogenetically. Tomato plants on cocopeat substrate were inoculated individually with a bacterial suspension (optical density $[OD]_{600}$ 2.0). Controls included nitrogen–phosphate–potassium (NPK) fertilizer and tap water. The greenhouse experiment was laid out in a completely randomized design with five replications. Data were taken 30, 60, 90, and 120 days after inoculation. All four bacterial isolates could fix nitrogen, solubilize phosphate, and potassium and synthesize indole acetic acid in vitro. The 16S rRNA of the strains BF1P2-6, BF2P1-2, BF2P5-1, and BF4P2-5 were identified as *Pseudomonas putida* Y22, *Pseudomonas taiwanensis* GDLB-32, *Pseudomonas monteilii* Bil-NOR3_15, and *Pseudomonas fluorescens* Y5, respectively. The strains grew best at pH 7, NaCl 0.0%, and 35°C. Inoculated tomato plants tested over a period of 4 months in a greenhouse showed a significant increase in growth, leaf variables, and yield attributes. *Pseudomonas*-inoculated plants were the highest in tannins (46.96 mg/100 g), followed by lycopene (45.57 mg/100 g) and Carotenoids (31.87 mg/100 g). The antioxidant activity of tomato fruit extracts showed the potential for free radicals scavenging activity against 2, 2-diphenyl-1-picrylhydrazyl. Conditions such as pH and electrical conductivity for the cocopeat substrate were within acceptable limits. Bacterial strains and NPK increased cocopeat nitrogen, phosphate, and potassium bioavailability. This study reveals that *Pseudomonas* strains improve plant growth, yield, and health-related phytochemical substances in tomato fruits, which could broaden their application in fruit and vegetable crops.

iCB 2023-26

The isolation, screening, and characterization of polyhydroxyalkanoate-producing bacteria from hypersaline lakes in Kenya

Abstract

Abstract: Extremophilic microorganisms such as those that thrive in high-salt and high-alkaline environments are promising candidates for the recovery of useful biomaterials including polyhydroxyalkanoates (PHAs). PHAs are ideal alternatives to synthetic plastics because they are biodegradable, biocompatible, and environmentally friendly. This work was aimed at conducting a bioprospection of bacteria isolated from hypersaline-alkaliphilic lakes in Kenya for the potential production of PHAs. In the present study, 218 isolates were screened by Sudan Black B and Nile Red A staining. Of these isolates, 31 were positive for PHA production and were characterized using morphological, biochemical, and molecular methods. Through 16S rRNA sequencing, we found that the isolates belonged to the genera Arthrobacter spp., Bacillus spp., Exiguobacterium spp., Halomonas spp., Paracoccus spp., and Rhodobaca spp. Preliminary experiments revealed that Bacillus sp. JSM-1684023 isolated from Lake Magadi had the highest PHA accumulation ability, with an initial biomass-to-PHA conversion rate of 19.14% on a 2% glucose substrate. Under optimized fermentation conditions, MO22 had a maximum PHA concentration of 0.516 g/L from 1.99 g/L of cell dry weight and 25.9% PHA conversion, equivalent to a PHA yield of 0.02 g/g of biomass. The optimal PHA production media had an initial pH of 9.0, temperature of 35 ∘C, salinity of 3%, and an incubation period of 48 h with 2.5% sucrose and 0.1% peptone as carbon and nitrogen sources, respectively. This study suggests that bacteria isolated from hypersaline and alkaliphilic tropical lakes are promising candidates for the production of polyhydroxyalkanoates.

Key Words: isolation; screening; characterization; polyhydroxyalkanoates; PHA; Lake Magadi; Lake Simbi; Bacillus sp.

iCB 2023-27

Selection of tolerant sorghum varieties grown in a striga infested field for future breeding purposes

Abstract

Sorghum is a crucial food security crop with outstanding potential to meet growing global demand for food at a time of uncertainty posed by climate change. Striga (*Striga hermonthica*) is an important parasitic weed in sorghum causing huge loses under heavy infestation. Fourteen sorghum lines were assessed for their response to Striga infection under field condition to select lines that seem tolerant to Striga infection for future breeding purposes. An introgression line, Asareca T1, tolerant to Striga and Tabat, susceptible to Striga were included as controls. The experiment was carried out in a Striga sick field at the Food Crop Improvement Centre, Kenya Agricultural and Livestock Research Organization (KARLO) experimental fields in Alupe, Busia County. It comprised of two nitrogen fertilizer levels: N0 (N_o nitrogen) and N_1 (90 kg N Ha^{-1}) laid out in a randomized complete block

design with two replications. Application of fertilizer significantly reduced days to Striga emergency, Striga count, and days to maturity, while it increased plant height, grain yield, panicle length, and dry weight in Asareca T1, 2026, 2038, 2048, 2054, and 2060. Striga count was negatively correlated with plant height (r = -0.81, p < 0.05), grain yield (r = - 0.74, p < 0.05), dry weight (r = - 0.78, p < 0.05), days to Striga emergence (r = - 0.64, p < 0.05), and panicle length (r = - 0.74, p < 0.05) in Tabat, 2011, 2015, 2021, 2028 and 2030. Striga count was positively correlated to number of tillers (r = 0.66, p < 0.05) and days to maturity (r = 0.76, p < 0.05) in Tabat, 2028, 2015, 2006, 2011, 2012, and 2006. The application of optimum fertilizer 60 kg ha^{-1} suppressed Striga emergence. It was also found that Tabat, 2006, 2011, 2012, 2015, 2021, 2028, and 2030 lines were susceptible to Striga attack based on the total number of Striga seedlings attached, which was more than six. Sorghum lines Asareca T1, 2026, 2029, 2038, 2040, 2048, 2054, and 2060 seem to be tolerant to Striga infectivity. Therefore, these lines have been selected for inclusion in future breeding programmes in selecting sorghum lines that are tolerant to Striga and that are preferred by farmers. Considerable efforts have been invested in breeding for Striga tolerance in sorghum and significant progress has been made in the development of improved selection methods.

Key Words: *Striga hermonthica*, Sorghum bicolor, strigolactones, Striga-sick field, susceptibility, hosts, tolerance

iCB 2023-28
Post-attachment resistance to *Striga hermonthica* in finger millet (*Eleusine coracana*)

Kunguni, J. S., Kibet, W., Oduori, C. O., Dida, M. M., **Anami, S.**, Kilian, B., Josiah M. Mutuku, J. M., Runo, S. & Odeny, D. A. (2023). *Weed Research*.
Abstract
Finger millet is a highly nutritious and climate-resilient cereal crop. Despite its importance, finger millet productivity in East Africa trails other cereals due to several biotic and abiotic factors, including the parasitic weed, *Striga hermonthica*. *Striga* spp. are noxious parasitic weeds whose damage can result in 100% yield losses in sub-Saharan Africa. The objective of our study was to determine differences in post-attachment responses of a selection of genotypes. We germinated finger millet in Petri dishes, transferred them to rhizotrons and infected the roots with *Striga* that had been pre-conditioned for 7 days at 30°C and subsequently pre-germinated using GR24. Histological analysis was done on three distinct genotypes to determine the host–pathogen interactions. The attachment of *Striga* onto the host was observed 3 days after inoculation. LESK10, a wild genotype, and OKHALE1 (cultivated) consistently supported fewer *Striga* plants after inoculation, while GBK029646A, a cultivated finger millet, consistently supported the highest. Histological analysis recorded an incompatible reaction in both OKHALE1 and LESK10 and a compatible reaction in GBK029646A as early as 3 days after infection. Our results suggest the likely existence of novel resistance in crop wild relatives that will be valuable for developing durable resistance to *Striga* in elite finger millet varieties.

Key Words: GR24, millet, parasitic plant, post-attachment resistance, rhizotrons, witchweed

CRISPR-Cas9-induced targeted mutagenesis of feruloyl CoA 6′-hydroxylase gene reduces postharvest physiological deterioration in cassava roots

Mukami, A., Juma, B. S., **Mweu, C.,** Oduor, R., & Mbinda, W. (2024). *Postharvest Biology and Technology*, *208*, 112649. https://doi.org/10.1016/j.postharvbio.2023.112649

Abstract

Cassava is a starch-rich, multipurpose root crop grown by millions of smallholder farmers in tropical and subtropical countries. Cassava cultivation is seriously constrained by post-harvest physiological deterioration (PPD) of roots that occurs within 24–72 h after harvest, making them unpalatable and unmarketable. The inevitable wounding of roots during harvest triggers an oxidative burst throughout the root together with the accumulation of secondary metabolites with scopoletin being the most abundant. Blue-black discoloration and vascular streaking observed during PPD occur due to over-accumulation of scopoletin whose biosynthesis involves key enzymes including feruloyl CoA 6′-hydroxylase. We applied the CRISPR-Cas9 system for targeted mutagenesis of feruloyl CoA 6′-hydroxylase genes (*MeF6'H1, MeF6'H12 MeF6'H2* and *MeF6'H3*) in cassava to delay PPD. To generate cassava plants with enhanced root shelf-life, CRISPR-Cas9 cassettes with Cas9 gene and sgRNA targeting three genes; *MeF6'H1, MeF6'H2,* and *MeF6'H3* were introduced into cassava via *Agrobacterium*-mediated transformation. Integration of transgenes in putative knockout plants were confirmed by PCR while targeted sanger sequencing revealed CRISPR-Cas9 induced mutations with insertion, deletions and substitution being reported upstream and downstream of the PAM sequence of target genes. Targeted for edition of dual genes exhibited significant reduction of scopoletin below HPLC detectable levels and had improved shelf-life compared to one gene knockout events and wild-type plants. Evaluation of phenotypic variations between mutant and wild-type cassava plants revealed mutation-event associated traits including stem and petiole depigmentation, auxiliary budding, claw-like leaf appearance, loss of apical dominance and leaf chlorosis. This study demonstrated an effective and feasible approach to extend cassava root shelf-life to stabilize yield production, prevent postharvest wastage, and improve farmers' income.

Key Words: Cassava, CRISPR-Cas9, Postharvest physiological deterioration (PPD), Shelf-life, storage roots

Assessment of genetic diversity of latent bacteria in coconut leaves associated with lethal yellowing disease symptoms in Kenya

Omar, F., **Neondo, J., Mweu, C.,** *& Muli, J. (2024). Plant Pathology. DOI: 10.1111/ppa.13856*

Abstract

Coconut (*Cocos nucifera*) is an economically important palm tree with diverse applications. However, limited scientific research exists on coconut diseases in the Kenyan coastal region. This cross-sectional study aimed to investigate the genetic diversity of latent bacteria associated with yellowing symptoms in coconut plants along the Kenyan coast. Sixty-two samples with symptoms were collected and their bacterial diversity assessed using culture-independent methods. DNA was extracted from controls and symptomatic samples using the cetyl trimethyl ammonium bromide (CTAB) method. Next-generation sequencing with Illumina MiSeq was used to profile the bacterial

communities using amplicons of 16S ribosomal RNA sequences (V4 region). Sequence data were analysed using the Quantitative Insights into Microbial Ecology 2 (QIIME 2) pipeline. A total of 113,330 reads were obtained, which clustered into 285 Operational Taxonomic Units. Bacterial diversity was highest in Kilifi, followed by Kwale and Lamu, while control samples exhibited low bacterial diversity. Actinobacteria was the predominant phylum across all counties, and *Streptomyces* was the most abundant genus. Kilifi and Kwale counties were more affected than Lamu. This is a pioneer study that provides insight into the bacterial diversity associated with yellowing disease symptoms in coconut plants in Kenya and will help with future elucidation of the agents causing or exacerbating coconut disease symptoms.

Key Words: bacteria, coconut, diversity, next-generation sequencing, yellowing

iCB 2023-31

Molecular characterization of Doum palm (*Hyphaene compressa*) from selected regions of Kenya using chloroplast simple sequence repeats (cpSSR) markers
*Borlay, A. J., **Mweu, C. M.**, Nyanjom, S. G., Omolo, K. M., & Omire, A. (2023). Pakistan Journal of Botany, 55(3), 1013-1021.*

Abstract
Doum palm (*Hyphaene compressa*) is an enduring member of the Arecaceae family of plants, an essential multipurpose plant with exceptional features that serve as a socioeconomic resource for people in the East Africa region. The unavailability of genetic and genomic data leads to difficulties enhancing such a crop, thereby preventing the actualization of its agronomic and breeding potential, hence the need for characterization. This study included 64 genotypes of doum palm collected from four locations in Kenya and ten polymorphic chloroplast microsatellite markers. Locus Among the ten polymorphic cpSSRs studied, the OPCG13 locus exhibited the highest observed and expected heterozygosity. Across all loci, we detected the mean value of 10.145 for the gene flow parameter. The mean number of significant allele frequencies for the 79 alleles detected was 0.75, with a range of 0.531 to 0.89. The median was 0.0036, 0.341, and 0.275 for observed heterozygosity, predicted heterozygosity, and PIC, respectively. All 64 genotypes were sorted into three main categories using neighbor-joining clustering and STRUCTURE analysis. At the population level, PCoA analysis explained 51.66 percent of the variation. As a result of these findings, cpSSR markers were used for the first time to characterize selected doum palm germplasm, which signifies that such a marker helps study doum palms at the molecular level. Our findings indicate that doum palm species in Kenya have a reasonable genetic variation coupled with considerable heterozygosity; consequently, these doum palm genetic variations are essential for the genetic improvement, breeding, and conservation initiatives of doum palm genotypes in Kenya.

Key Words: Doum palm (*Hyphaene compressa*), Rural pastoralists, Arid and semi-arid Kenyans, Chloroplast SSR (cpSSR), Genetic diversity, Molecular characterization.

iCB 2023-32

Diversity of pathogenic bacteria and incidence of antibiotic resistant genes in water used in eateries

*Makori, A., **Neondo, J.**, Mwangi, I., & **Mweu, C.** (2023). Authorea Preprints. doi: 10.22541/au.167602178.88798876/v1*

Abstract

Water used in eateries is a potential reservoir for acquisition and dissemination of antibiotic resistance, and human exposure to antibiotic resistant bacteria (ARB) and antibiotic resistance genes (ARGs) in drinking water may pose an additional health risk. Antimicrobial resistome monitoring is currently not a routine standard check of drinking water by health sector in developing countries. In the present study, culture dependent and illumina sequencing techniques profiled the occurrence of rich bacterial genetic diversity and resistome conundrum in water used by eateries in selected open markets. Analyses were done using R software and QIIME2 software. Heatmap outputs exhibited the correlation contours of morphological, biochemical, antibiotic susceptibility and antibiotic resistance genes (ARG) of culturable bacteria. Results show the following prevalent genera per sampled site; Wakulima Eateries (*Acinetobacter* 44.180%), Wakulima Open Market (Duganella 28.201%), Gashororo Eateries (*Acinetobacter* 15.189%), Gashororo Open Market (*Acinetobacter* 30.675%) Mwerevu Eateries (*Acinetobacter* 40.823%) and Mwerevu Open Markets (*Curvibacter* 48.785%). The qnrD and sul2 ARGs were detected in all six samples, int1 and FloR were present in five samples while strB, catA and blaTEM were detected in single sample using qualitative PCR. These findings form critical reference data for development of bacterial pathogen surveillance toolkit in the area.

iCB 2023-33

Prevalence of subclinical mastitis, associated risk factors and antimicrobial susceptibility pattern of bacteria isolated from milk of dairy cattle in Kajiado Central sub-county, Kenya

*Michira, L., **Kagira, J.**, Maina, N., Waititu, K., Kiboi, D., Ongera, E., & Ngotho, M. (2023). Veterinary Medicine and Science, 9(6), 2885-2892. DOI: 10.1002/vms3.1291*

Abstract

Background: Literature is scarce on the occurrence of bovine mastitis and antimicrobial resistance among dairy animals kept by pastoralists in the Kenya. Objectives: A cross-sectional study was carried out to investigate the prevalence and risk factors of subclinical mastitis (SCM) and evaluate the antibiotic sensitivity of bacteria isolated from dairy cattle kept by farmers in Kajiado Central sub-county, Kenya. Methods: A total of 202 lactating cows from 40 farms were sampled. Milk from the cows was screened for SCM using the California mastitis test, and the bacteria present in the milk samples were determined using standard bacteriological methods. The sensitivity of the isolated coagulase-negative staphylococci (CNS) and Staphylococcus aureus against antibiotics was tested using the Kirby–Bauer disk diffusion method. Results: The prevalence of SCM at quarter- and cow-level was 31.7% and 53%, respectively. The prevalence of SCM was significantly higher (p < 0.05) in exotic breeds of cattle and those kept under an extensive system of production. A total of 19 bacterial species were isolated with the majority being CNS (40.1%), *S. aureus* (15.8%) and Micrococcus spp. (10.4%). S. aureusisolates showed varied resistance to the tested antibiotics with the highest resistance being against ceftazidime (75%), amoxycillin (50%) and streptomycin (46.9%). Several S. aureus isolates were resistant to oxacillin (34.4%) and cefoxitin (12.5%). CNSs were more

resistant against ceftazidime (79.1%), amoxycillin (34.6%) and oxacillin (32.1%). Majority (92%–100%) of the Staphylococcus spp. were highly sensitive to ciprofloxacin a fluoroquinolone and augmentin. Conclusions: The high prevalence of SCM and bacteria resistant to antibiotics shows a need for animal health professionals and farmers to develop strategies for the management of mastitis and antibiotic resistance in dairy cows in the study area.

Key Words: coagulase negative staphylococci, Kajiado, resistance, risk factors, subclinical mastitis

iCB 2023-34

Risk factors of mastitis and antibiotic susceptibility of *Staphylococcus aureus* and *Escherichia coli* isolated from cows kept by farmers in Githunguri Sub-County, Kenya
Kagira, J. M., Achoki, P., Wariara, F., Wanja, B., Kiarie, J., Cheruiyot, K., & Kung'u, M. P. (2023). Journal of Applied Life Sciences International, 26(4), 21-30.

Abstract

Mastitis poses a major challenge in dairy cattle farming as it leads to production and economic losses. Some mastitis causing bacteria have shown resistance to some antibiotic and the risk factors associated with the antimicrobial resistance (AMR) are not well understood. The current study assessed the prevalence and risk factors associated with occurrence of mastitis in dairy cows kept by small-holder farmers in Githunguri Sub-County, Kenya. Further, susceptibility of the isolated *Staphylococcus aureus* and *Escherichia coli* to commonly used antibiotics was evaluated. The study design was cross sectional where 91 milk samples from 40 farms were sampled from two wards in the study area. Structured questionnaires were used to assess risk factors of mastitis. The milk obtained from lactating cows was first subjected to California mastitis test (CMT) and then taken to microbiology laboratory for isolation and identification of *Staphylococcus aureus* and *Escherichia coli* using standard bacteriological tests. Antibiotics sensitivity of the isolated bacteria was examined using disc diffusion method. Based on CMT, the overall prevalence of mastitis was 50.5%. The prevalence of mastitis was associated ($p<0.05$) with hygiene levels, being highest (69.2%) in the dairy cattle whose udder and leg hygiene were dirty. Highest prevalence of mastitis ($p<0.05$) was found in cows who were not milked regularly (52.4%) compared to those who were milked regularly (47.6%) ($p<0.05$). Cows which were cleaned using bore hole water had higher prevalence (53.3%) of mastitis compared to those cleaned using tap water (46.7%) ($p<0.05$). Cows that produced between 21-30 liters of milk per day had the highest prevalence (66.7%) of mastitis, while those producing between over 30 liters milk per day had lower prevalence (25%) ($p<0.05$). The prevalence of S. aureus and E. coli were 30.8% and 12.1%, respectively. *Staphylococcus aureus* isolates showed varied resistance to all the tested antibiotics with the highest resistance being against Oxytetracycline (57.7%) and Tetracycline (38.5%) but were sensitive to Vancomycin (100%), Ampicillin (100%), Chloramphenicol (96.2%), Penicillin (92.3%) and Gentamycin (92.3%). All the *Escherichia coli* isolates were sensitive to Chloramphenicol, Kanamycin, Gentamycin and Oxytetracycline but were resistant to Ampicillin (88.9%) and Vancomycin (88.9%) amongst other antibiotics. In conclusion, half of the sampled cows had mastitis whose risk factors was associated with poor hygiene and irregular milking of the cows. The isolated bacteria showed varied resistance to commonly used antibiotics. To reduce the prevalence of the mastitis and AMR, there is need for extension service workers to train farmers on improved management of the mastitis.

iCB 2023-35

Prevalence and Potential Risk Factors for the Acquisition of Antibiotic-Resistant Staphylococcus spp. Bacteria Among Pastoralist Farmers in Kajiado Central Subcounty, Kenya

*Ong'era, E., **Kagira, J.**, Maina, N., Kiboi, D., Waititu, K., Michira, L., & Ngotho, M. (2023). BioMed Research International, 2023. https://doi.org/10.1155/2023/3573056*

Abstract

Antimicrobial resistance (AMR) is a growing health problem globally. To address this challenge, there is a need to generate baseline data on the prevalence and AMR profile of the main disease-causing bacteria. Here, we interrogated the prevalence of bacteria in the nasal cavity of healthy pastoralists in Kajiado Central Subcounty, Kenya, and the occurrence of AMR in Staphylococcus isolates among the study subjects. Nasal swabs from 176 pastoralists were cultured, and the bacteria isolates identified using standard phenotypic and biochemical bacteriological methods. Among the obtained 195 isolates, the most prevalent isolates were coagulase-negative Staphylococcus (CoNS) (44.9%), followed by *Enterococci* spp. (43.2%) while *Staphylococcus aureus* prevalence was 8%. Antimicrobial sensitivity of the *Staphylococcus* spp. isolates to 14 antibiotics representing six antibiotic groups was undertaken using the Kirby-Bauer disk diffusion method. Among the CoNS, the highest resistance was reported in amoxicillin (78.7%) and ceftazidime (76%), while the most resistance for *S. aureus* was reported in ceftazidime (100%), amoxicillin (71.4%), and streptomycin (71.4%). From an administered questionnaire looking at gender, animal contact frequency, history of hospital visitation and antibiotic usage, and habitual intake of raw milk, the study showed that male participants had a higher risk of carrying multiple drug resistant (MDR) bacteria than females (p = 0.02, OR = 1.3). Likewise, habitual intake of raw milk was significantly associated MDR acquisition (p = 0.02, OR = 1.82). This study reveals a high prevalence of AMR Staphylococcus isolates in the study area laying a foundation for further analysis of molecular characterization of the observed resistance as well as the development of interventions that can reduce the occurrence of AMR in the study area.

iCB 2023-36

Big opportunities for tiny bugs: rush to boost laying hen performance using black soldier fly larvae meal

*Wamai, L. K., Munga, L. M., **Osuga, I. M.**, Munguti, J. M., Subramanian, S., Kidoido, M. K., Ghemoh, J. C., Mwendia, C. M. & Tanga, C. M. (2024). Journal of Economic Entomology, 117(1), 58-72.*

Abstract

Rising feed cost challenges due to expensive conventional protein sources continue to make headlines in Africa causing drops in profit margins. We assessed the impact of insect (*Hermetia illucens* Linnaeus larvae meal, HILM) protein as a substitute for soybean meal and sunflower seed cake on layer chicken performance and profitability. Our results showed that apart from the growers, chicks (12.37 g/bird) and layer hens (2.02 g/bird) fed diets with 75% HILM inclusion levels had significantly higher average daily weight gain. The average daily feed intake (ADFI) and feed

conversion ratio (FCR) varied significantly when the chicks and layer hens were provided with the HILM-based diets. For the chicks and layer hens, the lowest ADFI and FCR were observed in birds subjected to diets with 75% and 100% HILM compared to the growers fed diets with 50% HILM. Significantly higher egg production was observed for layer hens fed diets containing 75% of HILM throughout the first (87.41%) and second (83.05%) phase production cycles. Layer hens fed HILM-based diets had a 3–10% increase in egg laying percentage. There was higher profit margins when birds were fed diets containing 75% of HILM (~1.83 and 5.98 US$ per bird), which mirrored the return on investment estimated at 63.95% and 33.36% for the pullets (growers) and laying hen, respectively. Our findings demonstrate that diets with 75% HILM provided optimum growth performance, reduced feeding costs, increased weight gain and egg production as well as improved economic returns for commercial on-farm poultry production systems.

Key Words: black soldier fly, insect protein, alternative poultry feed, ISA Brown chicken, profitability

iCB 2023-37
Utilization of black soldier fly (*Hermetia illucens*) larvae as a potential substitute for fish meal in the production of Nile Tilapia (Oreochromis niloticus L.)
*Munguti, J., Wekesa, F., **Osuga, I.**, Kariuki, M., Yossa, R., Mungai, D., Kyule, D., Abwao, J., Opiyo, M., Obiero, K., Outa, N., Ogello, E., Iteba, J., Kirimi, J. G., Maundu, A., Liti, D. & Tanga, C. M. (2024). Sustainable Agriculture Research, 13 (1), 40-49. doi:10.5539/sar.v13n1p40*

Abstract
Utilization of quality aqua-feed relies heavily on fish meal sources of protein because of its nutritional balance. However, due to its limited supply, high cost, and decline of wild fish populations, aquaculture production has shifted focus to cheaper and more readily available alternatives to guarantee sustainable aquaculture productivity. Black soldier fly (Hermetia illucens) larvae are a promising replacement for fish meal in fish diets due to their relatively high crude protein, lipid and mineral contents, and the bioactive potential with anti-microbial, and other probiotic properties. This study determined the effect of partially replacing fish meal with black soldier fly meal (BSFLM) on the growth performance of Nile tilapia (Oreochromis niloticus). Four isonitrogenous (30% crude protein) diets in which fish meal protein was gradually substituted with BSFLM were prepared as follows: No BSFLM (control)-T0; 25% (BSFLM25)-T25, 50% (BSFLM50)-T50 and 75% (BSFLM75)-T75. The feeds were fed to the Nile tilapia fingerlings (mean weight 25 ±5 g) which were randomly stocked in 12 cages at a stocking density of 30 fish per cage. The experimental fish were manually fed at 3% of the body weight for 28 days, and 4% of the body weight for 154 days twice a day. The study found that 25% and 50% replacement of fish meal protein with BSFLM resulted in the best growth performance of Nile tilapia, as measured by final mean body weight gain (BWG), specific growth rate (SGR), feed conversion ratio (FCR) and condition factor (K). This suggests that BSFLM is a promising alternative to fish meal in aqua-feeds in the production of Nile tilapia.

Key Words: black soldier fly larvae, nutrition, tilapia, sustainability, aquaculture

Smallholder cattle farmers' perceptions, adoption potential, and utilization of trees and shrubs as livestock feeds in the Eastern Democratic Republic of the Congo

*Barwani, D. K., Maindi, C. N., Bacigale, S. B., Katunga, D. M., **Gicheha, M. G.**, & **Osuga, I. M.** (2023). International Journal of Agricultural Sustainability, 21(1), 2219910. DOI: 10.1080/14735903.2023.2219910*

Abstract

The sustainability of the livestock sector is negatively affected by insufficient quality and quantity of feeds. The effects of population growth and climate change further exacerbate the availability of feeds. Therefore, developing feasible low-cost strategies to improve year-round feed availability for enhanced livestock production is necessary. The use of trees and shrubs fodder has been recommended as a potential strategy to address feed scarcity. This study evaluated the perceptions, adoption potential, and utilization of trees and shrubs as livestock feeds in the Eastern Democratic Republic of the Congo (DRC) by employing a survey of 805 randomly sampled cattle farmers. The findings revealed that farmers utilized about 62 trees and shrubs for animal fodder. The farmers employed experience-based perceptions to evaluate the suitability of trees and shrubs for fodder based on animal and tree-related criteria. A probit model analysis results indicated that the utilization of trees and shrubs as livestock feeds were influenced by several household demographic factors, livestock farms, farming system factors, and institutional characteristics. The findings provide relevant insights into informing policy formulation and implementation that promote tree and shrub fodder utilization for improved livestock production under smallholder production systems.

Key Words: Milk production; smallholder cattle farmers; probit model; protein supplements; trees and shrubs

Influence of soil fertility management technologies on phosphorus fractions, sorption characteristics, and use efficiency in humic Nitisols of Upper Eastern Kenya

*Otieno, E. O., **Lenga, F. K.**, **Mburu, D. M.**, Kiboi, M. N., Fliessbach, A., & Ngetich, F. K. (2023). Heliyon, 9(12). e22859. https://doi.org/10.1016/j.heliyon.2023.e22859*

Abstract

Fractions of phosphorus (P) and its sorption characteristics are affected by different soil fertility (FM) technologies which ultimately affect crop growth and productivity. However, the response of P fractions and sorption characteristics to soil fertility technologies that integrate diverse amendments is still poorly understood in acidic Nitisols. A randomized complete block design was layout in an acidic Nitisol to determine fractions of P, its sorption characteristics and use efficiencies in acidic Nitisols under various FM technologies in field conditions. The use of minimum tillage + maize residue + inorganic fertilizer + goat manure (MTCrGF) had the highest impact on and significantly increased resin-Pi, NaHCO$_3$-Pi, and maximum P sorption (S$_{max}$) by 182, 76, and 52 mg P kg^{-1}. Moreover, NaOH-Pi and S$_{max}$ concentrations were higher under conventional tillage + maize residue + inorganic fertilizer + goat manure (CTCrGF) by 216 mg P kg^{-1} and 49 mg P kg^{-1} than the control. MTCrGF and CTCrGF also had the lowest P bonding energy (0.04 L mg^{-1}). CTCrGF had the highest P partial productivity factor (0.093 and 0.140 kg biomass kg^{-1} P) and P agronomic

efficiency (0.080 and 0.073 kg biomass kg^{-1} P) during the two cropping seasons. The results demonstrate the positive influence of combining multiple P sources on soil P fractions, sorption characteristics, and use efficiencies. Notably, combining either conventional or minimum tillage with maize straw and applying integrated manure and inorganic fertilizer (MTCrGF or CTCrGF) can increase the labile P concentrations and reduce the potential depletion of the non-renewable rock phosphate and the use of inorganic phosphatic fertilizers for agricultural production.

Key Words: Fractionation, Inorganic fertilizer, Langmuir equation, Organic amendments

iCB 2023-40
Shallow-incorporated straw returning further improves rainfed maize productivity, profitability and soil carbon turnover on the basis of plastic film mulching
Cheruiyot, W. K., Zhu, S. G., Indoshi, S. N., Wang, W., Ren, A. T., Cheng, Z. G., Zhao, Z. Y., Zhang, J. L., Lu, J. S., Zhang, X. C., Munyasya, A. N., Zhao, L., Koskei, K., Ma, M. S. Mburu, D. M., Nyende, A. B. & Xiong, Y. C. (2023). Agricultural Water Management, 289, 108535. <u>*https://doi.org/10.1016/j.agwat.2023.108535*</u>

Abstract
Ridge and furrow plastic film mulching (RFM) has improved net primary productivity (NPP) to a high level in semi-arid rainfed agricultural regions. Yet, it is unclear whether there is still a room for further improvement on NPP while stabilizing soil organic carbon through returning previous maize stover pieces. To address this issue, maize stubbles were smashed into pieces and in situ ploughed into 30 cm topsoil at a semi-arid site in northwest China from 2016 to 2017. This was done using the Pioneer *335* maize variety with three treatments (CK, ridge and furrow without mulching; RFM, ridge and furrow with plastic mulching; RFML, 3.49 t ha^{-1} of maize stover returning in RFM; RFMH, 5.24 t ha^{-1} of returning in RFM). The results indicated that maize stover returning exhibited similar trend as RFM at early cool seedling stage, raising the topsoil temperature. However, in warm and dry silking stage (2017), both stover returning rates reduced soil temperatures by 1.33 and 0.8 °C relative to RFM and CK ($P < 0.05$), respectively. The soil water storage increased significantly in RFMH by 17.3% and RFML by 28.5% relative to that of RFM, in a warm and dry growing season (2017). Critically, stover returning increased ($P < 0.05$) soil organic carbon and light fraction organic carbon turnover across the two growing seasons. By improving hydrothermal conditions, stover returning in RFM increased biomass accumulation and grain yield ($P < 0.05$), leading to higher ($P < 0.05$) net economic benefit, with greater above-ground biomass NPP (74.5–93.2%) and below-ground biomass NPP (88.5–89.4%), compared with CK. In conclusion, maize stover returning of stover pieces into topsoil might be a promising solution to enhance carbon turnover for higher net primary productivity on the basis of plastic film mulching in semiarid rainfed region.

Key Words: Ridge-furrow plastic-mulching (RFM), Maize stover returning, Soil hydrothermal condition, Soil organic carbon turnover, Net primary productivity

iCB 2023-41
Dynamics of land use land cover change in an East African inland valley wetland
Gimbo, R., Mukundi, J. B., Mburu, D. M., & Balirwa, J. S. (2024). African Journal of Ecology, 62(1), e13202. DOI: 10.1111/aje.13202

Abstract

The dynamics of inland valley wetlands landuse landcover (LULC) changes are of ecological and economical significance hence necessitating up-to-date datasets of resource status. Nalwekomba inland valley wetland is highly agriculturally utilised yet ecologically important wetland threatened with conversion. Historical LULC data sets as bench marks justifying wetland conservation are lacking. Therefore, the spatial–temporal LULC changes in Nalwekomba inland valley wetland were analysed through a combination of remote sensing and GIS, using satellite images of 1990, 2000, 2010 and 2020 as reference years. Results revealed variable dominance of grassland and tree cover for the wetland and its catchment over the years; 32.7% and 35.3% and 30.9% and 29.8%, respectively, for 1990 and 41.4% and 30.4% and 26.3% and 29.1% for 2020. The 30-year analysis revealed increasing area-shifts for cropland and built-up/settlement of 265.7% and 76.2%, respectively, reducing cover for shrubland by 78.31% in the wetland. Similar trend emerged for its catchment. Highest net cover gains and losses identified between 1990 and 2000 were for cropland and tree cover respectively. The observed trend points to the need for landuse planning and landcover management to enhance ecosystems' resilience to support sustainable livelihoods dependent on this ecosystem.

Key Words: ecological implications, inland valley, land use change, landuse landcover, Nalwekomba wetland

Cultivar-specific responses of tomato essential oils to tomato red spider mite (*Tetranychus evansi*): Implications for pest management

Murungi, L. K., Agong, S., Masinde, P., Hassanali, A., & Knapp, M. (2023). Open Research Africa, 6, 19. https://doi.org/10.12688/openresafrica.14334.1

Abstract

Background: The tomato (*Solanum lycopersicum* L.) is a widely cultivated and nutritionally valuable plant species, known for its culinary and health benefits. However, tomato crops are susceptible to various pests, including the tomato red spider mite (*Tetranychus evansi*), which can cause substantial yield losses. Essential oils from plants have shown potential as natural alternatives for pest management. *Methods*: This study investigated the interaction between essential oils from seven different tomato accessions namely; 1 (money maker), 13 (marglobe), 51 (PI 134417), 162 (JKUAT 22/202183), 182 (JKUAT 19), 428 (LA 2185) and 460 (LO 3279) and *T. evansi*. The aim was to understand the role of essential oils in shaping mite behavior. Essential oils were extracted from these diverse tomato accessions using steam distillation. The response of spider mites to these essential oils was assessed using Y-tube olfactometer and glass slide bioassays. Gas chromatography/mass spectrometry was used to analyze the composition of volatile compounds released by the essential oils. *Results*: Spider mite responses to different concentrations of essential oils were not significantly different among accessions. However, specific accessions, such as 51 and 428, elicited negative responses across concentrations. Analysis of volatile compounds revealed qualitative and quantitative variations in essential oil composition among accessions. Compounds like 2-tridecanone, 2-undecanone, β-caryophyllene, and α-humulene exhibited distinct abundance patterns across accessions. *Conclusions*: The study provides insights into the complex interaction between tomato

essential oils and spider mite behavior. While concentrations of essential oils did not strongly influence mite responses, the unique composition of essential oils in different accessions played a crucial role. These findings suggest the potential for selective breeding of tomato varieties with specific essential oil profiles to enhance resistance to spider mites. The research contributes to our understanding of natural pest management strategies and underscores the importance of phytochemical diversity in shaping arthropod behavior.

Key Words: arthropod behavior, pest management, tomato essential oils, *Tetranychus evansi*, tomato accessions, volatile compounds

iCB 2023-43

Effects of different rangeland management practices on vegetation metrics and wildlife abundance in a semi-closed ecosystem in north-central Kenya

Kaaria, T. N., **Ngamau, C. N.** *& Kimiti, D. W. (2023). Journal of Agriculture, Science and Technology, 22(4), 1-15. DOI: 10.4314/jagst.v22i4.1*

Abstract

Rangelands contribute at least 30% of terrestrial net primary productivity, making them an important part of natural ecosystems despite low and unpredictable rainfall regimes. Rangelands are sensitive to anthropogenic activities, making management interventions key to maintaining forage quality and quantity for wildlife. This study explored the effects of mowing of grasslands and carrying away (MO), prescribed grazing (PG), and unprescribed grazing (UG) on above-ground biomass, basal gaps, and wildlife abundance at Lewa Wildlife Conservancy in Meru, Kenya. Data collection was done 18 months after treatment for PG and MO, while UG was continuous. Treated blocks were selected in a systematic and random way, while adjacent untreated plots acted as controls. Blocks were divided into 100 m× 100 m grid cells using ArcMap 10.8. 1, where sampling plots were drawn. T-statistics and analysis of variance (ANOVA) tests were used to test statistical significance. We found a significant reduction in the aboveground biomass between MO and its control (t= 4.886, p= 0.003) and between UG and its control (t= 5.487, p= 0.007). No significant change was observed between PG and its control (t= 1.192, p= 0.287). MO increased wildlife abundance (t=-4.670, p= 0.003), while PG (t= 0.589, p= 0.583) and UG (t=-0.262, p= 0.803) showed no difference compared to their controls. The mean length of basal gaps between MO and its control decreased (t= 7.069, p= 0.001), while those between UG and its control increased (t=-4.053, p= 0.001), with no effect observed between PG and its control (t= 1.882, p= 0.061). This study recommends the use of mowing of grasslands and carrying away on rangelands as it positively influence the metrics under investigation.

Key Words: Prescribed grazing, unprescribed grazing, mowing of grasslands and carrying away, basal gaps, above-ground biomass.

iCB 2023-44

Urban food production technologies, innovations and management practices in Africa

Wesonga, J. M. *(2023). In: Fanadzo, M., Dunjana, N., Mupambwa, H.A., Dube, E. (eds). Towards Sustainable Food Production in Africa. Sustainability Sciences in Asia and Africa. Springer, Singapore. https://doi.org/10.1007/978-981-99-2427-1_17*

Abstract

With the world population estimated to reach 9.7 billion by 2050, of which 68% are expected to live in urban areas, there is an urgent need to reorganise the food system for urban areas. The COVID-19 pandemic lay bare the vulnerabilities in the current food systems, clearly showing their inabilities to cope with shocks and extreme events. The urban poor, living in informal settlements, are at the greatest risk of malnutrition as well as extreme heat due to the urban heat island phenomenon. Urban food production has immense potential to alleviate the problems of food insecurity and malnutrition but is hindered by various challenges including lack of time, space and expertise. In some cases, regulations imposed by urban authorities may impede urban food production. Technologies and innovations such as vertical farming systems including green walls and rooftop farming with the use of containers and soilless substrates can overcome the challenge of lack of space. Water shortage challenge can be overcome through use of water saving technologies such as hydroponic systems, capillary wick irrigation and wicking bed gardens. Technologies and innovations such as mushroom cultivation, microgreens and sprouts, aquaponics, cuniculture (rabbit rearing) and insect rearing have potential to provide nutrient dense foods rich in protein and other vital nutrients to the urban dwellers. Several of these technologies can utilise waste streams generated in the urban areas, thereby contributing to waste management in the urban areas. Several cities around the world have recognised the critical role that urban farming can play in dealing with various challenges in urban areas and have begun initiatives to promote urban farming. For instance, widespread growing of edible plants and vegetables in urban areas can be found in Europe, Japan, China, South Korea and the USA. In Japan, the Pasona Urban Farm owned by Pasona Group demonstrates the feasibility of urban food production. Urban farming should be integrated in the African food system to address the urban food insecurity. Initiatives to create awareness about technologies available for farming in the urban areas should be enhanced. Capacity building should be undertaken to produce a generation of agricultural practitioners that recognise and appreciate urban farming. Research should be conducted to optimise the various technologies and customise them to suit different situations. Policy makers should recognise and appreciate the importance of urban farming and develop friendly policies to enhance adoption for food and nutrition security with minimum environmental impacts.

Key Words: Urban farming, Urbanisation, Climate change, Vertical farming, Nutrition sensitive agriculture, Foodscaping

iCB 2023-45

African traditional use of edible insects and challenges towards the future trends of food and feed

Abstract

In the current times of climate change, the intense use of insects as a protein source is gaining popularity worldwide, and will likely contribute to increased nutrient intake in food and feed due to its nutritional, ecological, nutraceutical, and medicinal potential. Ancient traditional consumption of wild-harvested insects in Africa is a valuable but diminishing resource. There is a need for improved technology in insect rearing to match production with the current population pressure since we can no longer depend on wild collection. The current legislation within the European Union opens a

pathway towards acceptance, increased consumption, and marketing of edible insects, which already had a big role in African nutrition as a portion of seasonal food. Food security and expensive animal protein sources are a setback in Africa and there is a need to search for alternative sources to curb malnutrition. Insect use in animal feed is gaining momentum in pig, fish, pet, and poultry feed. To meet the rising demand for insect protein in animal feed, it calls for new ways to increase availability while addressing food quality, safety, and environmental sustainability. Apart from their importance as a source of nutrients, insects help to recycle organic waste, and the remaining portion can be used in plant protection and as a soil modifier. This review, therefore, undertakes exploration and outlook on the ancient utilisation of edible insects in Africa, current efforts to improve through farming, and the challenges faced with the hope that traditional practices will shape the future of the edible insect industry.

Key Words: cultural use, chitin, entomophagy, food security, wild harvesting

iCB 2023-46

Consumer preferences and willingness to pay for dried traditional mangos from Kitui–A marketing analysis for Kenya and Germany

*Uckert, G., Cavicchi, A., Soika, J., Matavel, C., Mule, M., Lerantilei, S., **Turoop, L.**, Mutia, T., Ronner, E., Mithöfer, D. & Sieber, S. (2023). Frontiers in Sustainable Food Systems, 7, 1113930. doi: 10.3389/fsufs.2023.1113930*

Abstract
The Kenyan mango value chain faces high post-harvest losses due to poor market access alongside a lack of storage technologies and processing facilities. Thus, using fruit processing methods, like solar drying, can enhance shelf life and help smallholder farmer's access new markets, diversifying income and livelihoods. Nonetheless, the processing of both indigenous and grafted mango fruits is not a very common practice. This study was conducted to support product development targeting processing and marketing to link farmers to both local and export markets. Four independent consumer testing and sensory evaluation rounds on Kitui's dried mango flakes were conducted in Germany and Kenya. Data were collected via a group tasting by 31 randomly selected participants and an online questionnaire of 304 randomly selected participants. All participants were given samples of different varieties of dried mango flakes with and without additives. Results show that high-quality mango cultivars, like Ngowe, receive high hedonic scores without any additives (honey, sodium metabisulfite, or ascorbic acid). Some varieties positively respond to the treatments and achieve higher scores, e.g. Van Dyke or the indigenous variety Kikamba. The consumers testing in Germany show that extrinsic attributes, such as organic production, fair trade, cooperative, and sustainable labelled flakes open up new opportunities for farmers who aim for the export market. Against findings derived from German panellists, in Kenya, consumers do not show a higher willingness to pay despite having a positive attitude toward sustainability. Thus, the local market should focus on cost-reduction strategies rather than introducing standardization.

Key Words: smallholder farmers, post-harvest losses, market opportunities, consumer tasting panels, shelf life, processing facilities, solar dryers

iCB 2023-47

SEGS-1 a cassava genomic sequence increases the severity of African cassava mosaic virus infection in *Arabidopsis thaliana*

*Rajabu, C. A., Dallas, M. M., Chiunga, E., De León, L., **Ateka, E. M.**, Tairo, F., Ndunguru, J., Ascencio-Ibanez, J. T. & Hanley-Bowdoin, L. (2023). Frontiers in Plant Science, 14, 1250105. https://doi.org/10.3389/fpls.2023.1250105*

Abstract

Cassava is a major crop in Sub-Saharan Africa, where it is grown primarily by smallholder farmers. Cassava production is constrained by Cassava mosaic disease (CMD), which is caused by a complex of cassava mosaic begomoviruses (CMBs). A previous study showed that SEGS-1 (sequences enhancing geminivirus symptoms), which occurs in the cassava genome and as episomes during viral infection, enhances CMD symptoms and breaks resistance in cassava. We report here that SEGS-1 also increases viral disease severity in *Arabidopsis thaliana* plants that are co-inoculated with African cassava mosaic virus (ACMV) and SEGS-1 sequences. Viral disease was also enhanced in Arabidopsis plants carrying a SEGS-1 transgene when inoculated with ACMV alone. Unlike cassava, no SEGS-1 episomal DNA was detected in the transgenic Arabidopsis plants during ACMV infection. Studies using *Nicotiana tabacum* suspension cells showed that co-transfection of SEGS-1 sequences with an ACMV replicon increases viral DNA accumulation in the absence of viral movement. Together, these results demonstrated that SEGS-1 can function in a heterologous host to increase disease severity. Moreover, SEGS-1 is active in a host genomic context, indicating that SEGS-1 episomes are not required for disease enhancement.
Key Words: SEGS-1, begomovirus, ACMV, *Arabidopsis thaliana*, cassava

iCB 2023-48

Strigolactone biosynthesis lgs1 mutant alleles mined from the sorghum accession panel are a promising resource of resistance to witchweed (Striga) parasitism

*Mutinda, S., Jamil, M., Wang, J. Y., Berqdar, L., **Ateka, E.**, Bellis, E. S., Al-Babili, S. & Runo, S. (2023). Plants, People, Planet, 2023; 1-14. DOI: 10.1002/ppp3.10442*

Abstract

Societal Impact Statement: Striga is a parasitic plant that greatly limits the production of Africa's most staple cereals, including sorghum. Infection occurs when the parasite germinates in response to biomolecules emitted into the soil from the host's roots. Some sorghum genotypes harbor a mutation that makes them ineffective in stimulating *Striga* seed germination. This resistance is of great importance because of its possible application in *Striga* management. Here, additional resistant sorghum genotypes with varying levels of *Striga* resistance are discussed in the context of their candidacy for integration in breeding programs and their possible role in alleviating food insecurity in sub-Saharan Africa by reducing crop losses because of *Striga* infestation. *Summary*: Sorghum is a food staple for millions of people in sub-Saharan Africa, but its production is greatly diminished by *Striga*, a parasitic weed. An efficient and cost-effective way of managing *Striga* in smallholder farms in Africa is to deploy resistant varieties of sorghum. Here, we leverage genomics and the vast genetic diversity of sorghum—evolutionarily adapted to cope with *Striga* parasitism in Africa—to identify new *Striga*-resistant sorghum genotypes by exploiting a resistance mechanism hinged on communication molecules called strigolactones (SLs), exuded by hosts to trigger parasite seed

germination. We achieved this by mining for mutant alleles of the *LOW GERMINATION STIMULANT 1* (*LGS1*) that are ineffective in stimulating *Striga* germination from the sorghum accession panel (SAP). Our analysis identified *lgs1* sorghum genotypes, which we named SAP-*lgs1*. SAP-*lgs1* had the SL exudation profile of known *lgs1* sorghum, whose hallmark is the production of the low inducer of germination, orobanchol. Laboratory and field resistance screens showed that the SAP-*lgs1* genotypes also exhibited remarkable resistance against *Striga*. Our findings have the potential to reduce crop losses because of *Striga* parasitism and therefore have far-reaching implications for improving food security in Africa.

Key Words: allele mining, food security, Low germination stimulant 1, Striga resistance, strigolactones, sub-Saharan Africa, witchweed

iCB 2023-49
CRISPR/Cas, transcriptomics, and RNA interference in virus disease management

Abstract
Plant viruses infect a wide range of commercially important crop plants and cause significant crop production losses worldwide. Numerous alterations in plant physiology related to the reprogramming of gene expression may result from viral infections. Although conventional integrated pest management-based strategies have been effective in reducing the impact of several viral diseases, continued emergence of new viruses and strains, expanding host ranges, and emergence of resistance-breaking strains necessitate a sustained effort toward the development and application of new approaches for virus management that would complement existing tactics. RNA interference-based techniques, and more recently, clustered regularly interspaced short palindromic repeats (CRISPR)-based genome editing technologies have paved the way for precise targeting of viral transcripts and manipulation of viral genomes and host factors. In-depth knowledge of the molecular mechanisms underlying the development of disease would further expand the applicability of these recent methods. Advances in next-generation/high-throughput sequencing have made possible more intensive studies into host−virus interactions. Utilizing the omics data and its application has the potential to expedite fast-tracking traditional plant breeding methods, as well as applying modern molecular tools for trait enhancement, including virus resistance. Here, we summarize the recent developments in the CRISPR/Cas system, transcriptomics, endogenous RNA interference, and exogenous application of dsRNA in virus disease management.

Key Words: CRISPR/Cas, plant genomics, plant viruses, RNA silencing, RNA-seq

iCB 2023-50
Cassava begomovirus species diversity changes during plant vegetative cycles

Abstract

Cassava is a root crop important for global food security and the third biggest source of calories on the African continent. Cassava production is threatened by Cassava mosaic disease (CMD), which is caused by a complex of single-stranded DNA viruses (family: *Geminiviridae*, genus: *Begomovirus*) that are transmitted by the sweet potato whitefly (*Bemisia tabaci*). Understanding the dynamics of different cassava mosaic begomovirus (CMB) species through time is important for contextualizing disease trends. Cassava plants with CMD symptoms were sampled in Lake Victoria and coastal regions of Kenya before transfer to a greenhouse setting and regular propagation. The field-collected and greenhouse samples were sequenced using Illumina short-read sequencing and analyzed on the Galaxy platform. In the field-collected samples, African cassava mosaic virus (ACMV), East African cassava mosaic virus (EACMV), East African cassava mosaic Kenya virus (EACMKV), and East African cassava mosaic virus-Uganda variant (EACMV-Ug) were detected in samples from the Lake Victoria region, while EACMV and East African mosaic Zanzibar virus (EACMZV) were found in the coastal region. Many of the field-collected samples had mixed infections of EACMV and another begomovirus. After 3 years of regrowth in the greenhouse, only EACMV-like viruses were detected in all samples. The results suggest that in these samples, EACMV becomes the dominant virus through vegetative propagation in a greenhouse. This differed from whitefly transmission results. Cassava plants were inoculated with ACMV and another EACMV-like virus, East African cassava mosaic Cameroon virus (EACMCV). Only ACMV was transmitted by whiteflies from these plants to recipient plants, as indicated by sequencing reads and copy number data. These results suggest that whitefly transmission and vegetative transmission lead to different outcomes for ACMV and EACMV-like viruses.

Key Words: plant virus, Cassava (*Manihot esculenta*), vegetative (asexual) propagation, vector transmission, whitefly (*Bemisia tabaci*)

iCB 2023-51
Occurrence and distribution of viruses associated with papaya ringspot disease in Kenya
Mumo, N. N., Ateka, E. M., Mamati, G. E., Rimberia, F. K., & Ochieng' Asudi, G. (2023). DOI: 10.5897/AJPS2023.2308

Abstract

Papaya ringspot disease is a serious threat to papaya production in Kenya. For effective management, it is important to determine the occurrence and distribution of the viruses associated with the disease. A survey was conducted in 2017, covering a total of 103 papaya fields in major papaya production areas in the country. To determine the disease incidence, 20 plants per field were visually inspected for symptoms associated with the disease. Disease severity was evaluated on a scale of 1 to 5, while disease prevalence was determined as the proportion of fields showing disease symptoms per county expressed as a percentage. A total of 287 leaf samples were collected from surveyed fields and tested for Moroccan watermelon mosaic virus (MWMV), cowpea mild mottle virus (CpMMV), and papaya mottle-associated virus (PaMV) using polymerase chain reaction (PCR)-based techniques. The highest (71.4%) disease incidence was recorded in Kiambu County, while the lowest was recorded in Busia County (2.8%). No symptomatic plants were observed in Siaya and Bungoma (0%) counties. Disease prevalence ranged from 0 to 100%. The highest disease severity, 4.0, was reported in Baringo County; while the lowest, 2.0, was reported in Kwale, Kilifi, and Taita Taveta counties. MWMV was

the most prevalent, with 140 out of 287 samples testing positive and also widespread, having been detected in 11 out of the 22 counties surveyed. PaMV was the second most prevalent, detected in 39 out of 287 samples collected and in 9 out of 22 counties. CpMMV was the least prevalent, detected in 7 out of 287 samples and in three counties. The occurrence of both MWMV and PaMV was detected in five counties, while the occurrence of PaMV and CpMMV was detected in three counties. The presence of MWMV, PaMV and CpMMV was detected in one county. Viruses associated with papaya ringspot disease in Kenya are widespread in papaya-growing regions, with some counties reporting 100% disease prevalence. The development and implementation of control strategies for the disease in the country are of paramount importance. In the future, it is important to identify factors influencing disease spread in the country for effective management.

Key Words: Incidence, viral diseases, control strategies, farmers, interventions.

iCB 2023-52
Passion fruits resilience to global warming and climate change
*Chebet, D., Savini, I., & **Rimberia, F. K.** (2023). In Cultivation for Climate Change Resilience, Volume 1 (pp. 146-162). CRC Press.*

Abstract
The major world producers of passion fruit are Australia, Hawaii, South Africa and Brazil. In Brazil, yellow passion fruit accounts for 95% of production, while the purple passion fruit accounts for the remaining 5%. The fruit has high nutritional and medicinal value. It is a rich source of Vitamins A and C and contains fair amounts of iron, potassium, sodium, magnesium, sulphur and chlorides and has dietary fiber and protein. Fruits are eaten fresh or processed into products like jams, squash, juice, cakes, pies and ice-cream. Passion fruits are adapted to climates ranging from cool subtropical to warm tropical, but are sensitive to extremes of both low and high temperatures. Purple passion fruit does well in the upper midland to upper highland zones. Yellow passion fruits do well in the lower midland and lowland zones. Passion fruits develop continuously in the tropics and require a constant supply of water to enable continuous flowering and fruiting.

iCB 2023-53
Papaya resilience to global warming and climate change
*Chebet, D., Savini, I., & **Rimberia, F. K.** (2023). In Cultivation for Climate Change Resilience, Volume 1 (pp. 127-145). CRC Press.*

Abstract
Papaya is a fast growing tropical and subtropical fruit crop with both nutritional and health benefits. Production of this crop is threatened by a myriad of challenges arising from global warming and climate change. These challenges include periodic droughts and flooding, high temperatures as well as increased incidences of pest and disease infestation. Various management strategies including efficient irrigation, use of higher yielding, drought and disease tolerance varieties, integrated pest management, conservation agriculture, greenhouse production, carbon dioxide enrichment, inoculation with arbuscularmycorrhiza fungi among others will go a long way in ensuring continued survival and productivity of papaya. In this chapter climatic requirements, impact of global warming and climate change, crop management under changed climate conditions as well as strategies for

minimizing this impact on papaya production are discussed. Geographic Information System (GIS), remote sensing (RS) and satellite imaging technologies are proposed for improving the efficiency of site-specific crop management. This will generate data for specific crop requirements thus improving timeliness and efficiency on the requisite response. Genetic engineering is mentioned as a tool for speeding up breeding for resistance against biotic and abiotic stresses.

iCB 2023-54

The effect of indigenous Arbuscular mycorrhizal fungi (AMF) on phyto-accumulation in Carica papaya hybrids

Muiruri, J. W., **Rimberia, F. K.**, **Mwashasha, R. M.**, *& Kavoo, A. M. (2023). African Journal of Food, Agriculture, Nutrition and Development, 23(10), 24783-24800.*

Abstract

Papaya (*Carica papaya* L.) is a climacteric fruit with a resilient and distinctive aroma. The consumption of the fruit is global due to its high nutritive and medicinal values. However, there has been low production of quality papaya fruits due to unavailability of crucial mineral elements in the soils. The current study therefore, focuses on the effect of indigenous arbuscular mycorrhizal fungi (AMF) as a biofertilizer on the quality of papaya fruits. In order to verify AMF effectiveness on papaya fruits, four treatments were used: AMF inoculum only, composted farm yard manure (FYM) only, combination of AMF inoculum and compost FYM and control where only soil and sand media were used at a ratio of 1:1. Jomo Kenyatta University of Agriculture and Technology (JKUAT) and Malkia papaya hybrids were used. The papaya seeds from JKUAT and Malkia papaya hybrids were sown in trays and transplanted at 3 leaves stage into 5 litre pots within a green house. The AMF spores were bulked using sorghum plants to obtain the AMF inoculum. The treatments were added into the soil media of the papaya plantlets at a ratio of 1:3, every 4 weeks after first transplanting until they were 20 weeks old. They were then transplanted to 100 litre containers, where completely randomized design was used and replication of six papaya plants for each treatment and hybrid. Watering, weeding and cooling the green house with water fumes was carried out when necessary; as the papaya plants grew until the fruits attained physiological maturity. The fruits were separately harvested and ripened to a predetermined stage. They were then analysed for moisture content, crude fibre, minerals (nitrogen, phosphorous, potassium, magnesium, calcium, iron and zinc), ascorbic acid, total carotenoids and total polyphenols. Data obtained was subjected to two-way ANOVA at $p \leq 0.05$ significance level; means were separated using Tukey's HSD test in Genstat's 15th edition. JKUAT hybrid with AMF inoculum treatment had 3.07%crude fibre and 8.42mg/100g phosphorous content while JKUAT hybrid with both AMF inoculum and manure treatments had 4.9 % crude fibre and 9.88 mg/100g phosphorous content. Malkia and JKUAT hybrids with compost FYM treatment had potassium content of 98.31mg/100g and 109.4 mg/100g respectively while the controls had 31.58 mg/100g and 35.32mg/100g respectively. Incorporating soil media with manure and AMF inoculum improved the nutritive quality of papaya fruits and this was contingent on papaya hybrids.

Key Words: Biofertilizer; inoculum; mineral elements; nutritive quality; physiological maturity

iCB 2023-55

Implication of abandoned post-quarry sites on avifauna composition for strategic landscape restoration in Ndarugu, Kiambu, Kenya

Abstract

Abandoned post-quarry sites have potentiality to be remodeled into natural-wilderness areas, a desire especially in rapidly urbanizing and transforming landscapes. However, paucity of ecological information on post-quarry sites limits nature-based restoration, especially in the sub-Saharan tropical landscape. This study investigated avifauna composition of post-quarry sites in Ndarugu, Kenya, relative to non-quarried sites for conservation role prioritization. Birds were censused in 166 point count stations using the fixed-radius distance method. Land use land cover types within each point provided the variables for explaining bird occurrence. Observed bird species were classified into functional guilds, avifaunal composition assessed, and bird data subjected to multivariate analysis. In total 158 species, 128 in post-quarry and 123 in non-quarried sites, were recorded. Bush- and forest-related species were dominant, constituting over 55% of total observed birds, in both site categories. Six wetland-related species were detected only in quarried sampling sites. Mann–Whitney statistical tests returned a significant effect of land use category on bird species richness, abundance, and diversity, all higher in post-quarried than in non-quarried sites ($p < 0.05$). Emergent natural shrubs, quarry cliffs, and cultivated farms were most influential to bird community structuring. Nonmetric multidimensional scaling and cluster analysis revealed four functional groups of birds whose species richness increased with number of post-quarried sampling sites in a cluster. Unique physical features of post-quarry sites and emergent vegetation types, can be partially mimicked in nature-oriented rehabilitation planning for long-term social and ecological benefits.

Key Words: bird functional group, ecological restoration, emergent habitat, post-quarry sites, species richness

iCB 2023-56

Heavy metal occurrence within urban agriculture practices in eastern zones of Nairobi city

Abstract

Urban agriculture although growing in importance, requires farmer practices to adapt to dynamics of urbanization having implication on quality of produce and public perception. The objective of this research was to assess heavy metal occurrence in inputs and food crops for urban farms in the eastern zone of Nairobi, determine differences in element uptake by crops and to examine influence of environmental quality of the surrounding spaces. A quasi research design approach was used to identify farm plots for field survey in three locations. Samples of tomatoes (*Lycopersicon esculentum*), arrowroots (*Colocasia esculenta*), and kales (*Brassica oleraceae var. Acephala*), water and soil samples were collected. Concentration of cadmium, manganese, zinc and lead were analysed using Atomic Absorption/Flame Emission Spectrophotometer. One way ANOVA was used to examine mean differences of heavy metals between locations and compare transfer factor (TF) index

of the crops. Elements that were above allowable limits (mg/kg) in the crops were Cd (1.7 - 4.49), Mn (62.54 - 89.15), Pb (0.161 - 0.56) and Zn (0.44 - 4.95) in arrowroots; Cd (1.76 = 5.27) and Mn (3.65 = 26.86) in kales and Cd (1.17-3.51), in tomatoes. Cadmium content was highest in farm plots within Kasarani (2.44±0.86 mg/kg) and was significantly different from other two locations ($p < 0.05$, Tukey HSD test). Between the neighbourhood qualities, heavy metal contents were different but not significant ($p > 0.05$) between classes. The mean TF index for the heavy metals decreased in the order Cd>Pb>Zn>Mn. Transfer factor index of more than 1 for cadmium was observed in arrowroots, kales and tomatoes. Based on FAO/WHO standards, the measured heavy metal contents were high for health concern. Produce from areas designated as of low environmental quality, were not necessarily contaminated as perceived. Urban agriculture producers in Nairobi need technical risk reduction measures and legislative support to guarantee quality produce and valuable participation in the urban food system framework.

Key Words: Urban farming, environmental quality, cadmium, lead, transfer factor, edible produce, health risk

Abstract
The study compared the management of state-owned parks, community and private conservancies in five conservation areas. The objectives of the research were to assess the degree of community involvement in conservation management and analyze the public benefits and costs associated with conservation areas at the Coast, Southern, Central Rift and Mt. Kenya regions. A purposeful sampling of populations along the 5 km buffer zone was undertaken. The data collection techniques used questionnaires, one-on-one interviews, observation and existing secondary data. The SPSS was used for data analysis. The following variables were tested for correlations and associations; types of resources and practiced land use, diminishing resources and practiced land use, types of conflicts and types of resources, types of animals and types of resources. Results indicated that farming (31.8%) was the preferred type of land use followed by farming and livestock keeping (21%), and livestock keeping (18.4%), among other activities. Pearson's Chi-square noted a degree of association between the types of resources and practiced land use, the types of resources and land ownership, the diminishing resources and the type of resources and conflict of resources, the means of sustaining family and disadvantages of living next to the park. There was a positive significant correlation between the type of conflict and conservancy benefits ($r = 0.201$, $p < 0.000$, $n = 659$) at 0.05. Most communities preferred community and private conservancies based on conflict resolution measures, compensation for damages, economic benefits, and community involvement in decision making and sharing of resources within conservation areas.

Key Words: Conservation, Conflicts, Management, Resources

iCB 2023-58

Association mapping of candidate genes associated with iron and zinc content in rice (*Oryza sativa* L.) grains

*Bukomarhe, C. B., Kimwemwe, P. K., **Githiri, S. M.**, **Mamati, E. G.**, Kimani, W., Mutai, C., Nganga, F., Nguezet, P. M. D, Mignouna, J., Civava, R. M. & Fofana, M. (2023). Genes, 14(9), 1815.*

Abstract

Micronutrient deficiencies, particularly of iron (Fe) and zinc (Zn), in the diet contribute to health issues and hidden hunger. Enhancing the Fe and Zn content in globally staple food crops like rice is necessary to address food malnutrition. A Genome-Wide Association Study (GWAS) was conducted using 85 diverse rice accessions from the Democratic Republic of Congo (DRC) to identify genomic regions associated with grain Fe and Zn content. The Fe content ranged from 0.95 to 8.68 mg/100 g on a dry weight basis (dwb) while Zn content ranged from 0.87 to 3.8 mg/100 g (dwb). Using MLM and FarmCPU models, we found 10 significant SNPs out of which one SNP on chromosome 11 was associated with the variation in Fe content and one SNP on chromosome 4 was associated with the Zn content, and both were commonly detected by the two models. Candidate genes belonging to transcription regulator activities, including the bZIP family genes and MYB family genes, as well as transporter activities involved in Fe and Zn homeostasis were identified in the vicinity of the SNP markers and selected. The identified SNP markers hold promise for marker-assisted selection in rice breeding programs aimed at enhancing Fe and Zn content in rice. This study provides valuable insights into the genetic factors controlling Fe and Zn uptake and their transport and accumulation in rice, offering opportunities for developing biofortified rice varieties to combat malnutrition among rice consumers.

Key Words: rice; Fe and Zn content; genetics; SNP markers; GWAS; gene identification

iCB 2023-59

Population structure and genetic diversity of Rice (*Oryza sativa* L.) germplasm from the Democratic Republic of Congo (DRC) using DArTseq-Derived single nucleotide polymorphism (SNP)

*Kimwemwe, P. K., Bukomarhe, C. B., **Mamati, E. G.**, **Githiri, S. M.**, Civava, R. M., Mignouna, J., Kimani, W. & Fofana, M. (2023). Agronomy, 13(7), 1906.*

Abstract

Understanding the genetic diversity and population structure of rice is crucial for breeding programs, conservation efforts, and the development of sustainable agricultural practices. This study aimed to assess the genetic diversity and population structure of 94 rice (*Oryza sativa* L.) genotypes from the Democratic Republic of Congo using a set of 8389 high-quality DArTseq-based single nucleotide polymorphism (SNP) markers. The average polymorphic information content (PIC) of the markers was 0.25. About 42.4% of the SNPs had a PIC value between 0.25 and 0.5, which were moderately informative. The ADMIXTURE program was used for structure analysis, which revealed five sub-populations (K = 5), with admixtures. In principal component analysis (PCA), the first three principal components accounted for 36.3% of the total variation. Analysis of molecular variance revealed significant variation between sub-populations (36.09%) and within genotypes (34.04%). The low overall number of migrants (Nm = 0.23) and high fixation index (F_{st} = 0.52) indicated limited gene

flow and significant differentiation between the sub-populations. Observed heterozygosity ($H_o = 0.08$) was lower than expected heterozygosity ($H_e = 0.14$) because of the high inbreeding ($F_{is} = 0.52$) nature of rice. A high average Euclidean genetic distance (0.87) revealed the existence of genetic diversity among the 94 genotypes. The significant genetic diversity among the evaluated rice genotypes can be further explored to obtain potentially desirable genes for rice improvement.

Key Words: population structure; genetic diversity; rice germplasm; DArTseq; single nucleotide polymorphism

iCB 2023-60
Phenotypic variation among rice (*Oryza sativa* L.) germplasm accessions for the Eastern Democratic Republic of Congo and traits association based on yield and yield components
*Kimwemwe, P. K., Bukomarhe, C. B., Mudarhi, L. B., Munkumba, D. D., Tshiabukole, J. P. K, Okonya, J. S., Warinda, E., Ndikumana, I., **Mamati, E. G.** & Fofana, M. (2023). FARA Research Report 7(49):622-641. https://doi.org/10.59101/frr072349*

Abstract
Genetic variation among genotypes and the association between yield with its components are critical information and prerequisite knowledge for a crop yield improvement program. Forty-nine rice genotypes were randomly selected from the germplasm accessions in the Eastern Democratic Republic of Congo for selection in a yield improvement program. The field experiment was conducted following a 7x7 triple lattice design in two locations, each with three replicates. Data were collected on fourteen morphological traits. The variation in the genotypes was explained by four principal components accounting for 78.7% of the total variation. Traits such as panicle length, plant height, number of primary branches/panicles, number of spikelets/panicles, number of filled grains/panicle, panicle weight, number of productive tillers/hill, grain yield, 1000 grains weight, grain length to grain width ratio were the major discriminator traits among the genotypes. High genotypic coefficient of variation than the environmental coefficient of variation was observed among the yield components. Moderate to high heritability and genetic advance exhibited by grain width, number of spikelets/panicles, number of filled grains/panicle, plant height, panicle length, 1000 grains weight, days to flowering, panicle weight, number of productive tillers/hill, and number of primary branches/panicle, indicating that these characters can be improved through selection. Grain yield reflected a significant and positive correlation with the number of productive tillers/hills, panicle weight, number of primary branches/panicle, number of filled grains/panicle, and number of spikelets/panicle. Selection can be based on such traits for grain yield improvement. Breeders should consider this information when selecting parents for grain yield improvement using this germplasm.

Key Words: Rice, phenotypic variation, trait selection, correlation, yield components

iCB 2023-61
Salinity and sodicity induced responses on total phenols, flavonoids and tannins accumulation on cowpea (*Vigna unguiculata* (L) walp)
*Mutuku, T., **Mamati, E.**, & Mutune, A. (2023). African Journal of Horticultural Science, 22, 73-80.*

Abstract

Food shortage remains a developmental hindrance in globally with about 25% of world's population suffering from continued food and nutritional insecurity especially in ASALs. Reduced arable tracts of land for cultivation, increased population and variation in non-living factors such as water and salinity are challenges facing the world. Cowpea is commonly grown on ASALs which are greatly affected by salinity. The study involved 4 cowpea varieties; K80, M66, Kunde 1 and KVU 27-1 that were subjected to both $CaCl_{2(aq)}$ and $NaCl_{(aq)}$ at levels of 0 (control), four, eight and twelve dS/m. A complete randomized design in replicates of three in a greenhouse was used at Jomo Kenyatta University of Science and Technology, Juja Sub county, Kiambu County on October 2021-January 2022.The salts concentrations (NaCl and $CaCl_2$) were applied to the soil from time of sowing and constant levels were monitored throughout by use of an EC probe Determination of total phenols, tannins, and flavonoids content was done using a UV-VIS spectrophotometer. The obtained data were evaluated using 2-way ANOVA at 5% significance level using SPSS (software version 21). As salinity and sodicity levels increased, the phenols, tannins and flavonoids content also increased. Variety M66 recorded the highest total phenols, tannins and flavonoids above 8 dS/m hence it developed a defense mechanism against salt stress. Therefore, variety M66 was better adapted to high salt levels because it performed better at high saline and sodic levels. Therefore, farmers especially in marginal areas affected by salinity should adopt growing of M66 cowpea variety.

Key Words: Cowpea, Phenolics, Salinity, Sodicity, UV-VIS spectrophotometer

iCB 2023-62
Plant regeneration from embryogenic callus-derived from immature leaves of *Momordica charantia* L.

Abstract

Bitter melon (*Momordica charantia* L.), a widely cultivated food and medicinal plant native to the world's subtropics and tropics, is a *Cucurbitaceae* rich in carotenoids. However, the low seed germination frequency and progeny variability associated with the production of this plant have a substantial impact on its growth and yield. These constraints affect the availability and exploitation of this crop, especially the fruits, which are rich in secondary metabolites such as β-carotene and α-carotene. *In vitro* regeneration would help overcome the obstacle linked to the germination of this plant and increase its yield and utilization. A reproducible *in vitro* organogenesis protocol was established using bitter melon embryogenic callus derived from immature leaf explants of *in vivo* grown seedlings and *in vitro* plantlets. Regeneration via callus was conducted on MSB5 media augmented with different plant growth regulator concentrations. The maximum frequency of callus formation (95.09 %) was produced in MSB5 media incorporated with 1.2 mg L^{-1} NAA augmented with 0.5 mg L^{-1} TDZ. MSB5 medium with no growth regulators was observed to be the most suitable for the shoot and root formation from the callus, producing a significantly high shoot percentage of 90.91 % and 21.53 shoots per explants, and the highest rooting frequency and root number of 88.92 % and 6.23 roots per explant, respectively, from leaf-derived callus of *in vitro* plantlets. The elongated plantlets had grown to a significantly higher average height of 12.20 cm on media added with

0.75 mg L^{-1} GA$_3$. This reproducible method for regenerating bitter melon plantlets could facilitate mass multiplication, conservation, and commercial field production.

Key Words: Callus induction, Leaf explants, Bitter melon, Root induction, Shoot elongation, Shoot induction

iCB 2023-63

Performances of plantlets from selected cassava (*Manihot esculenta* Crantz) genotypes under Semi-Autotrophic Hydroponics (SAH) using different substrates

Abstract

The cassava seed system faces challenges due to limited seed stock caused by a slow propagation rate and a lengthy growth period. Conventional methods lacking phytosanitary guarantees further compound these issues. To address these limitations, the Semi-Autotrophic Hydroponics (SAH) technology was adopted for the rapid mass propagation of healthy, disease-free cassava plants. This research aimed to evaluate the performance of cassava planting materials using different substrates for stem-cutting multiplication in the laboratory at the IITA Kalambo research station in DR Congo. The experiment followed a split-plot design of five replications of three consecutive sub-culture periods lasting four weeks each. Four different genotypes: IB961089A, MM060083, Nase14, and Albert28 as the main plots, with four different substrates: KlasmannTS3, Vermiculite, Local Peat, and Sawdust as the sub-plots, were laid out. Cuttings were placed in 500-ml substrate-filled boxes and watered weekly with a 100-ml Miracle-Gro solution. Data were collected on survival, height, leaf and internode numbers, and cutting numbers at the end of each subculture period. The data were analysed using ANOVA in R software. The Fisher's Least Significant Difference (LSD) test was utilised to separate means when significant differences among treatments were present ($p < 0.05$). The results showed that survival was primarily influenced by the substrate used, with KlasmannTS3 demonstrating the highest rate, exceeding 90%. Significant differences ($p < 0.05$) among genotypes for survival rate and performance parameters mentioned above ($p < 0.001$) were observed. Similarly, there were significant differences ($p < 0.001$) among substrates for survival rate and performance parameters. Furthermore, the interaction between genotype and substrate significantly ($p < 0.001$) affected performance parameters. MM060083 performed the best across all traits. KlasmannTS3 was the superior substrate and had the highest average cutting number regardless of genotype, with a notable increase of 292% from 20 to 58.4 cuttings, representing a ratio of 1: 3 within three months. Sawdust had the lowest multiplication rate, with a 5% decrease. The superior performance of KlasmannTS3 was attributed to its rapid growth and favourable properties. The interaction between MM060083 and KlasmannTS3 consistently showed the highest number of cuttings (70.4). Sawdust consistently showed poor growth performance, regardless of genotype. The study concludes that the SAH offers the potential for rapid multiplication of disease-free cassava planting materials in reduced space and time.

Key Words: Cassava genotypes; plantlets; growth performance; stem cuttings; multiplication; substrate; Semi - Autotrophic Hydroponics (SAH).

Genetic diversity and population structure analysis of Arabica coffee (*Coffea arabica* L.) germplasm collections in Burundi based on DArTseq.

Niyoyankunze, J. M. V., **Nyende, A. B.**, *Kyallo, M., Nibasumba, A., Nduwayo, G., & Shorinola, O. (2023). Universal Journal of Agricultural Research 11(2): 275-299, 2023. DOI: 10.13189/ujar.2023.110206*

Abstract

Coffee is the most important export commodity that contributes significantly to the national economy and supports the livelihood of millions of people in Burundi. The lack of information on the diversity of the existing pool of advanced breeding materials and introduced accessions of Arabica coffee in Burundi has been a key limitation for coffee improvement and sustainable conservation. To address this limitation, DArTseq Genotyping by sequencing (GBS) was used to document the genetic diversity of the Arabica coffee collection in Burundi. We analyzed 255 Coffea arabica germplasm composed of hybrid, commercial varieties, and landraces. A total of 4036 SNPs were identified and 3488 of those were found to be anchored to the C. arabica chromosomes. After quality filtering, 3070 highly informative SNPs were used for Linkage Disequilibrium (LD) pruning leading to 1874 LD-pruned markers employed for further genetic diversity analyses. A complementary approach involving distance-based (hierarchical clustering and Principal Coordinate Analysis) and model-based (ADMIXTURE and Discriminant Analysis of Principal Component) methods congruently stratified these 255 Coffea arabica germplasm into four genetic clusters. The group membership of the clusters identified throughout the two methods was comparable. Admixture between coffee accessions was evaluated using ADMIXTURE, and the best-fit number of populations (clusters) based on cross-validation estimates was K= 4. Based on genetic diversity parameters including Polymorphism Information Content, heterozygosity, and overall minor allele frequency, a relatively low genetic diversity was observed between and within the genetics groups. The analysis of the coffee genetic variation through Principal Coordinate analysis indicated a low variation of 22.1% among the existing coffee genotypes. This study documents genetic diversity presented of the C. arabica genetic resources in Burundi. These findings can be used in selecting and introducing parents for breeding in this lowdiversity collection to set up effective strategies for Arabica coffee improvement and conservation in Burundi.

Key Words: *Coffea Arabica*, Genetic Diversity, Coffee Breeding, Dartseq Genotyping, Allotetraploid

Aging rate, environmental risk and production efficiency of the low-density polyethylene (LDPE) films with contrasting thickness in irrigated region

*Xiong, X. B., Zhao, Z. Y., Wang, P. Y., Mo, F., Zhou, R., Cao, J., Liu, S. T., Zhang, F., **Kiprotich, W.**, Wang, Y. B., Fang, X. W., Tao, H. Y. & Xiong, Y. C. (2023). Ecotoxicology and Environmental Safety, 264, 115399. https://doi.org/10.1016/j.ecoenv.2023.115399*

Abstract

Physical thickness of low-density polyethylene (LDPE) films might determine the release rate of phthalic acid esters (PAEs) & structural integrity and affect production efficiency. However, this

critical issue is still unclear and little reported. Aging effects were evaluated in LDPE films with the thickness of 0.006, 0.008, 0.010 and 0.015 mm in a maize field of irrigation region. The Scanning electron microscope (SEM) results showed that the proportion of damaged area (Dam) to total area of LDPE films was massively lowered with increasing thickness after aging. The highest and lowest Dam was 32.2% and 3.5% in 0.006 and 0.015 mm films respectively. Also, the variations in peak intensity of asymmetric & symmetrical stretching vibrations (ASVI & SSVI) were detected using Fourier transform infrared spectrum (FTIR), indicating that the declines in peak intensity tended to be slower with thickness. Interestingly, the declines in physical integrity were tightly associated with increasing exhalation rate of PAEs. Average releasing rate of PAEs was 38.2%, 31.4%, 31.5% and 19.7% in LDPE films from 0.006 to 0.015 mm respectively. Critically, thicker film mulching can lead to greater soil water storage at plough layer (SWS-PL) and better thermal status, accordingly harvesting higher economic benefit. Therefore, LDPE film thickening may be a solution to reduce environmental risk but improve production efficiency in arid region.

Key Words: LDPE film thickness, Aging rate, PAEs, Water productivity, Dryland maize

iCB 2023-66
Plant biomass mediates the decomposition of polythene film-sourced pollutants in soil through plastisphere bacteria island effect

Zhao, Z. Y., Wang, P. Y., Xiong, X. B., Zhou, R., Li, F. M., Cheng, Z. G., Wang, W., Mo, F., **Cheruiyot, W. K.**, *Wang, W. Y., Uzamurera, A. G., Tao, H. Y. & Xiong, Y. C. (2023). Environment International, 178, 108114. https://doi.org/10.1016/j.envint.2023.108114*

Abstract
The polyethylene (PE) film mulching as a water conservation technology has been widely used in dryland agriculture, yet the long-term mulching has led to increasing accumulation of secondary pollutants in soils. The decomposition of PE film-sourced pollutants is directly associated with the enrichment of specific bacterial communities. We therefore hypothesized that plant biomass may act as an organic media to mediate the pollutant decomposition via reshaping bacterial communities. To validate this hypothesis, plant biomass (dried maize straw and living clover) was embedded at the underlying surface of PE film, to track the changes in the composition and function of bacterial communities in maize field across two years. The results indicated that both dry crop straw and alive clover massively promoted the α-diversity and abundance of dominant bacteria at plastisphere, relative to bulk soil. Bacterial communities tended to be clustered at plastisphere, forming the bacteria islands to enrich pollutant-degrading bacteria, such as *Sphingobacterium*, *Arthrobacter* and *Paracoccus*. As such, plastisphere bacteria islands substantially enhanced the degradation potential of chloroalkene and benzoate ($p < 0.05$). Simultaneously, bacterial network became stabilized and congregated at plastisphere, and markedly improved the abundance of plastisphere module hubs and connectors bacteria via stochastic process. Particularly, bacterial community composition and plastic film-sourced pollutants metabolism were evidently affected by soil pH, carbon and nitrogen sources that were mainly derived from the embedded biomass. To sum up, plant biomass embedding as a nature-based strategy (NbS) can positively mediate the decomposition of plastic-sourced pollutants through plastisphere bacteria island effects.

iCB 2023-67

Thickness effects of polyethylene and biodegradable film residuals on soil properties and dryland maize productivity

Uzamurera, A. G., Zhao, Z. Y., Wang, P. Y., Wei, Y. X., Mo, F., Zhou, R., Wang, W. L., Ullah, F., Khan, A., Xiong, X. B., Li, M. Y., **Kiprotich, W.,** *Wang, W. Y., Tao, H. Y. & Xiong, Y. C. (2023). Chemosphere, 329, 138602. https://doi.org/10.1016/j.chemosphere.2023.138602*

Abstract

Plastic film residuals are increasingly remaining in cultivated lands. However, it is a critical issue how residual plastic type and thickness affect soil properties and crop yield. To address this issue, in situ landfill was conducted using thick polyethylene (PEt1), thin polyethylene (PEt2), thick biodegradable (BIOt1), thin biodegradable (BIOt2) residues, and CK (control) with no residues landfill in a semiarid maize field. The findings demonstrated that the impact of various treatments on soil characteristics and maize yield varied considerably. Soil water content decreased by 24.82% in PEt1 and 25.43% in PEt2, compared to BIOt1 and BIOt2, respectively. BIOt2 treatment increased soil bulk density by 1.31 g cm^{-3} and lowered soil porosity by 51.11%, respectively; it also elevated the silt/clay proportion by 49.42% relative to CK. In contrast, microaggregate composition in PEt2 was higher (43.02%). Moreover, BIOt2 lowered soil nitrate (NO_3^-) and ammonium (NH_4^+) content. Compared with other treatments, BIOt2 resulted in significantly higher soil total nitrogen (STN) and lower SOC/STN. Finally, BIOt2 exhibited the lowest water use efficiency (WUE) (20.57 kg ha^{-1} mm^{-1}) and yield (6896 kg ha^{-1}) among all the treatments. Therefore, BIO film residues exhibited detrimental impacts on soil quality and maize productivity compared to PE film ones. Considering film thickness, thin residual films more evidently influenced soil quality and maize productivity than thick film ones.

iCB 2023-68

Can shallow-incorporated organic mulching replace plastic film mulching for irrigated maize production systems in arid environments?

Zhao, Z. Y., Wang, P. Y., Xiong, X. B., Zhou, R., Zhu, Y., Wang, Y. B., Wang, N., Kiprotich, W., Xue, W., Cao, J., Zhang, J. L., Tao, H. Y. & Xiong, Y. C. (2023). Field Crops Research, 297, 108931. https://doi.org/10.1016/j.fcr.2023.108931

Abstract

Context: Since the ridge-furrow farming with plastic film mulching has caused widespread environmental pollution in maize field, it is essential to explore a substitutive strategy to mitigate plastic residue pollution while the output remains unchanged. *Objectives*: This study aimed to investigate the potentials of shallow-incorporated organic mulching in replacement of polyethylene film mulching regarding maize productivity maintenance and its driving mechanism. *Methods*: Two-year (2019–2020) field experiment was conducted in an arid irrigation site of northwest China. There

were five mulching treatments as follows: 1) shallow-incorporated maize straw piece incorporating into soils across 10-cm depth; 2) living clover mulching; 3) plastic film mulching; 4) combined plastic film mulching and shallow-incorporated maize straw piece and 5) combined plastic film and living clover mulching. Conventional planting without mulching was the control. For each plot with straw pieces, maize straws were cut into small pieces by straw crusher, evenly spread on soil surface and incorporated into soils using rotary tiller. *Results*: Shallow-incorporated organic mulching treatments, including straw mulching and clover mulching, substantially promoted maize water productivity by 29.9% in straw mulching and 14.4% in clover mulching respectively, compared with the control. They achieved similar productivity level as plastic mulching or dual mulching treatments did. Both straw mulching and clover mulching also prolonged crop growth cycle by 10–20 days, and elevated soil temperature from the middle to late growing stage, relative to the plastic-involved treatments. Moreover, they significantly reduced field evaporation and accordingly promoted soil water storage, maintaining relatively fine hydro-thermal status. Particularly, both straw decomposition and clover biological nitrogen fixation contributed to more nitrogen input into soils at maturity. This resulted in a steady nitrogen accumulation into soils for rapid recovery growth at the later stage, i.e. excessive compensation for insufficient growth at the early stage (over-compensatory effect). Critically, shallow-incorporated organic mulching harvested higher net economic benefit by 3.3% in sole straw mulching and 10.4% in sole clover mulching relative to sole plastic film mulching respectively, while dual plastic and organic mulching decreased economic and ecological benefits. *Conclusion*: Shallow-incorporated organic mulching can obtain similar water productivity and economic benefit as polythene film mulching, as a result of over-compensation and biological nitrogen input into soils at late growing season. *Implications*: Polyethylene film mulching was not indispensable, and organic mulching may act as a green solution to displace film mulching according to local irrigation scheduling in arid irrigation region.

Key Words: Shallow-incorporated organic mulching, Polythene film mulching, Soil temperature, Maize yield, Water productivity, Irrigated area

iCB 2023-69
Inheritance of bacterial wilt resistance in five tomato cultivars
*Kathimba, F. K., Kimani, P. M., Narla, R. D., & **Kiirika, L. M.** (2023). Journal of Plant Breeding and Crop Science, 15(2), 63-73. DOI: 10.5897/JPBCS2022.1009*

Abstract
Five tomato cultivars were studied for inheritance of bacterial wilt resistance. Lines AVTO1429, AVTO1424, and AVTO1314 have the resistance gene, Roma VF lacks the resistance gene, and Valoria Select is claimed to have resistance but has not been evaluated. The study, which was carried out in a split plot design, involved six generations and backcrosses that were conducted in a greenhouse and a field. Artificial inoculation of Ralstonia solanacearum was carried out in greenhouse. Parental lines AVTO1429, AVTO1424 and AVTO1314 had the lowest incidence of 37.78, 26.67 and 26.67%, respectively while Roma VF had the highest at 95%. F1 hybrids had lower incidence of≤ 33.33% in all the crosses. Cross F1 x Parent 2 (BC2) had significantly lower disease incidence and severity compared to F2 hybrids, F1 x Parent 1 (BC1) and P1 (Roma VF) in all crosses. Computation of gene effects showed significant additive effects of 1.941 for cross Roma VF x AVTO1429 and 1.925 for cross Roma VF x Valoria select at p< 0.01. Dominance effects, additive x

additive, additive x dominance and dominance x dominance interaction in all the crosses were significantly different at p< 0.01. The important gene effects for bacterial wilt resistance inheritance was in additive and dominance-additive portions which implied that the resistance trait was inherited.

Key Words: *Ralstonia solanacearum*, tomato, resistance trait, inheritance, bacterial wilt.

Abstract
Strategies to manage bacterial wilt disease causing 64-100% yield loss have limited effectiveness. A 10×10 diallel mating design excluding reciprocals and self was employed in this study to evaluate combing ability effects, heterosis, and reaction to bacterial wilt in 10 tomato parents. Genotypes AVTO1424 (11.87%), AVTO1429 (12.29%) and AVTO1314 (13.53%) were found to have significantly lower disease incidence, demonstrating high levels of bacterial wilt resistance. Commercial varieties Roma VF (89.87%) and Cal J (79.60%) however had the highest disease incidence. Out of 45 F1 hybrids, 10 had an incidence 75% and severity score >4. The cross AVTO1429 x AVTO1314 had the lowest incidence (7%). Negative heterosis was recorded in 29 and 31% of the F1 hybrids during long and short rain respectively, with AVTO1429 x AVTO131 having the lowest at -50 and -37%. Cal J had the highest General Combing Ability while AVTO1314, AVTO1429 and AVTO1424 had the lowest. Cross UC82 x Valoria select and AVTO1429 x AVTO1424 had the highest Specific Combining Ability while cross Danny select x Riogrande had the lowest. Genotypes with bacterial wilt resistance trait and high combining ability have the potential in developing a breeding program.
Key Words: Bacterial wilt, combining ability, heterosis, *Ralstonia solanacearum*, tomato

Abstract
Arbuscular mycorrhizal fungi (AMF) are associated with plant roots and exhibit beneficial impacts such as stress tolerance and nutrient and water absorption. These functions opened the door to studying other fungi associated with AMF on the root's rhizosphere. This study aimed to characterize fungal isolates associated with rhizospheric indigenous AMF from different plant species (banana, grass and papaya) and agroecologies (Mwea, Mitunguu and Juja) in Central Kenya. A total of 30 fungal isolates were isolated from the soil samples through the pour plate technique. The isolates had diverse microscopic morphological characteristics ranging from form, margin, color, size, and surface. Physiochemical characteristics showed varied growth at different pH, temperature, and

salinity with optimum growth was recorded at pH 7.0, 30oC-35°C temperature, and salinity of 0-0.5M NaCl. The internal transcribed spacer (ITS) and AMF subunits sequences showed diversity similar to Aspergillus spp. Ajellomyces spp., Fusarium spp., Trichoderma spp., Penicillium spp., Glomus spp. and Diversispora spp. In conclusion, there is a symbiotic relationship between AMF and other fungal.

Key Words: Arbuscular mycorrhizal fungi, Fungal isolates, Morphological properties, Morpho-physiochemical properties, Rhizosphere

iCB 2023-72
Quality changes in papaya fruit under different storage temperatures and duration
Matsuane, C., **Kavoo, A. M.**, **Kiage, B. N.**, **Karanja, J.**, & **Wanzala, F. K. R.** (2023). *Journal of Agriculture, Science and Technology*, 22(3), 64-78. doi: 10.4314/jagst.v22i3.6

Abstract
Kenya experiences high postharvest losses in the fruit and vegetable subsector, which have been estimated at 50 percent. These losses are mainly due to poor postharvest handling practices, a lack of storage facilities, and/or poor storage conditions. Papaya (Carica papaya L.) is a highly perishable tropical fruit with a short shelf life and requires proper storage and handling practices due to its delicate skin texture, high moisture content, and high respiratory rates. In this study, F hybrid and Mountain variety papaya fruits were collected at Meru County in May 2022 and stored at three different temperatures (6, 16 and 24 C) for a duration of 0, 4, 8 and 12 days to evaluate their effects on fruit quality. The data collected was separately subjected to a two-way ANOVA in a completely randomised design using the GenStat statistical software package (14th edition). Storage temperatures and durations significantly ($p < 0.05$) decreased papaya quality. Mountain fruits were firmer while F fruits had more appealing peel and flesh colors. F fruits retained more potassium (1.20 g/100g) and vitamin C (0.29 g/100g) when stored at 16 C on day 12. The optimal storage temperature and duration for successful storage and extension of shelf life of papaya fruits was found to be 16 C for 8 days. The F hybrid fruits were more comparable to the local papaya variety, Mountain, on the various tested parameters, which could make it suitable for consumer utilization and market exploitation in Kenya.

Key Words: *Papaya carica*, postharvest, storage temperature, fruit quality, nutrient retention

iCB 2023-73
Integrated modelling of the determinants of household food insecurity during the 2020–2021 COVID-19 lockdown in Uganda
*Semakula, H. M., Liang, S., McKune, S. L., Mukwaya, P. I., Mugagga, F., Nseka, D., Wasswa, H., Kayima, P., Achuu, S. P., **Mwendwa, P.** & Nakato, J. (2024). Agriculture & Food Security, 13(1), 1-19. https://doi.org/10.1186/s40066-023-00460-2*

Abstract
The determinants of household food insecurity (HFI) do not act in isolation, and are known to be complex, stochastic, nonlinear, and multidimensional. Despite this being especially true in periods of shocks, studies that focus on integrated modelling of the HFI determinants during the COVID-19 lockdown are scarce, with no available evidence on Uganda. The main objective of this study was to develop Bayesian belief network (BBN) models to analyse, rank, and illustrate the conceptual

reasoning, and complex causal relationships among the determinants of HFI during the COVID-19 lockdown. This study was based on seven rounds of Uganda's High-Frequency Phone Surveys data sets collected during the lockdown. A total of 15,032 households, 17 independent determinants of HFI, and 8 food security indicators were used in this study. Metrics of sensitivity, and prediction performance were used to evaluate models' accuracy. Eight BBN models were developed for each food insecurity indicator. The accuracy rates of the models ranged between 70.5% and 93.5%, with an average accuracy rate of 78.5%, indicating excellent predictive performance in identifying the determinants of HFI correctly. Our results revealed that approximately 42.2% of the sampled households (n = 15,032) in Uganda were worried about not having enough food. An estimated 25.2% of the respondents reported skipping a meal, while 32.1% reported consuming less food. Less than 20% of the households experienced food shortage, hunger, or having nothing to eat. Overall, 30.6% of the households were food insecure during the lockdown. The top five ranked determinants of HFI were identified as follows: (1) households' inability to produce enough food; (2) households' inability to buy food; (3) reduced household income; (4) limited cash assistance, and (5) households' inability to stock adequate food supplies. Ranking, rather than the statistical significance of the determinants of HFI, is crucial as an approach to applied research, as it helps stakeholders determine how to allocate resources for targeted interventions within the constraints of limited funding. These findings emphasize the importance of intervening on the most highly ranked determinants of HFI to enhance the resilience of local food systems, and households' capacity to cope with recurring and unforeseen shocks.

iCB 2023-74
Bayesian belief network modelling approach for predicting and ranking risk factors for malaria infections among children under 5 years in refugee settlements in Uganda

Abstract
Background: Malaria risk factors at household level are known to be complex, uncertain, stochastic, nonlinear, and multidimensional. The interplay among these factors, makes targeted interventions, and resource allocation for malaria control challenging. However, few studies have demonstrated malaria's transmission complexity, control, and integrated modelling, with no available evidence on Uganda's refugee settlements. Using the 2018–2019 Uganda's Malaria Indicator Survey (UMIS) data, an alternative Bayesian belief network (BBN) modelling approach was used to analyse, predict, rank and illustrate the conceptual reasoning, and complex causal relationships among the risk factors for malaria infections among children under-five in refugee settlements of Uganda. *Methods*: In the UMIS, household level information was obtained using standardized questionnaires, and a total of 675 children under 5 years were tested for malaria. From the dataset, a casefile containing malaria test results, demographic, social-economic and environmental information was created. The casefile was divided into a training (80%, n = 540) and testing (20%, n = 135) datasets. The training dataset was used to develop the BBN model following well established guidelines. The testing dataset was used to evaluate model performance. *Results*: Model accuracy was 91.11% with an area under the

receiver-operating characteristic curve of 0.95. The model's spherical payoff was 0.91, with the logarithmic, and quadratic losses of 0.36, and 0.16 respectively, indicating a strong predictive, and classification ability of the model. The probability of refugee children testing positive, and negative for malaria was 48.1% and 51.9% respectively. The top ranked malaria risk factors based on the sensitivity analysis included: (1) age of child; (2) roof materials (i.e., thatch roofs); (3) wall materials (i.e., poles with mud and thatch walls); (4) whether children sleep under insecticide-treated nets; 5) type of toilet facility used (i.e., no toilet facility, and pit latrines with slabs); (6) walk time distance to water sources (between 0 and 10 min); (7) drinking water sources (i.e., open water sources, and piped water on premises). *Conclusion*: Ranking, rather than the statistical significance of the malaria risk factors, is crucial as an approach to applied research, as it helps stakeholders determine how to allocate resources for targeted malaria interventions within the constraints of limited funding in the refugee settlements.

Key Words: Bayesian belief network, Children, Malaria, Ranking, Refugees, Risk factors, Settlements, Uganda

iCB 2023-75
Toward sustainable transformation through postharvest management: Lessons from Kenya's mango value chain
*Ambuko, J., & **Owino, W.** (2023). Food Systems Transformation in Kenya, 433-467.*

Abstract

Management of postharvest food loss and waste (FLW) is an important strategy in efforts to sustainably meet the food and nutrition needs of the world's growing population. Sustainable food systems are critical to achieving food security and nutrition for all, now and in the future. Food systems cannot be sustainable when a large proportion of the food produced using limited resources is lost or wasted in the supply chain. At the global level, it is estimated that poor postharvest management means this is the case for 30 percent of the food produced for human consumption (FAO 2011, 2019). The figure for Kenya is similar (Ministry of Agriculture, Livestock, Fisheries and Cooperatives 2018). The 2021 Food Waste Index Report (UNEP 2021) indicates that every Kenyan wastes about 100 kg of food every year, which adds up to 5.2 million metric tons1 per year, excluding food loss that happens upstream, from production to retail. In monetary terms, wasteful consumption accounts for slightly over US$500 million annually (Mbatia 2021). FLW exacerbates food insecurity and has negative impacts on the environment through waste of precious land, water, farm inputs, and energy used in producing food that is not consumed. In addition, postharvest losses, caused by poor storage conditions, reduce income to farmers and contribute to higher food prices.

iCB 2023-76
Above and below-ground evaluation of the invasive cactus species *Opuntia stricta* in Laikipia, Kenya
*Oduor, K., Dubeux, J. C. B. Jr., **Owino, W.**, Ruiz-Moreno, M., Dantas Queiroz, L. M., Lima Bretas, I., Trumpp, K. R., Portuguez Acuna, J., Araujo Bernardini, M., Garcia, L., Lira Junior, M. A., & Simili, F. F. (2023) In ASA, CSSA, SSSA International Annual Meeting. ASA-CSSA-SSSA. St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/150870*

Abstract

Cactus *Opuntia stricta* is an exotic invasive species in Kenyan rangelands and the most problematic plant species to pastoral communities, especially in Laikipia County. The ability of the plant to tolerate marginal soils with low moisture and fertility has made it thrive in the region, outcompeting the native species. Eradication efforts have not been successful, prompting other sustainable approaches that are ecologically sound and beneficial to the community. An understanding of the above and below-ground responses of the species could provide important information for this endeavor; however, few studies have focused on this subject, particularly in Kenya. A field experiment was set up in a randomized complete block design with ten (10) replicates, each measuring 30×30 m. Subsequently, each block was subdivided into 10 x 30m plots. Above-ground biomass accumulation was monitored for three years by randomly assigning three harvest (yearly) frequencies to each plot. To assess the below responses, three clusters were randomly selected from each plot, and roots and soil were sampled along the cluster gradient from the center moving to the outside in radii, R1, R2, and R3. Samples were evaluated for root biomass and soil moisture. Significant differences *(P<0.001)* were observed for root biomass, soil moisture, aboveground biomass and the number of clusters. Root biomass along the cluster gradient ranged from 4527.0 to 9242.0 kg/ha for the outermost radius (R3) and the cluster's center, respectively. The one-year regrowth, one-year regrowth after the second harvest, and the two-year regrowth had dry biomass of 92.7, 69.8, and 62.5 kg/ha respectively. This findings demonstrate that harvesting cactus can contribute to its sustainable management while still contributing to the belowground biomass. This is imperative in sustaining the ecological functions of rangeland soils such as those found in Laikipia, Kenya

iCB 2024-77
Lenticels are sites of initiation of microcracking and russeting in 'Apple'mango
*Athoo, T. O., Winkler, A., **Owino, W. O.**, Knoche, M. (2023). PLoS ONE 18(9): e0291129. https://doi.org/ 10.1371/journal.pone.0291129*

Abstract

The mango cultivar 'Apple' is an important fruitcrop in Kenya, but it is highly susceptible to russeting. The objective was to establish whether lenticels predispose cv. 'Apple' mango to russeting. Fruit mass and surface area increased in a sigmoidal pattern with time. The frequency of lenticels per unit surface area decreased during development. The number of lenticels per fruit was constant. Lenticels were most frequent in the apex region and least common in the cheek and nak (ventral) regions. The cheek region also had lenticels with the largest core areas, whereas the lenticel core areas in the apex region were significantly smaller. Microscopy revealed stomata became covered over with wax deposits at 33 days after full bloom (DAFB). By 78 DAFB, periderm had formed beneath the pore. At 110 and 161 DAFB, cracks had developed and the periderm had extended tangentially and radially. The presence of lenticels increased the strain released upon excision of an epidermal segment, further strain releases occurred subsequently upon isolation of the cuticle and on extraction of the cuticular waxes. The number of lenticels per unit surface area was negatively correlated with the fruit surface area ($r^2 = 0.62$ **), but not affected by fruit size. Mango cv. 'Apple' had fewer, larger lenticels and more russet, compared with 'Ngowe', 'Kitovu' or 'Tommy Atkins' mango. In cv. 'Apple', the lowest lenticel frequency, the largest lenticels and the most russeting occurred at a growing site at the highest altitude, with the highest rainfall and the lowest temperature. Moisture exposure of the fruit surface resulted in enlarged lenticels and more microcracking of the cuticle. Our

results establish that russeting in 'Apple' mango is initiated at lenticels and is exacerbated if lenticels are exposed to moisture.

iCB 2024-78
Effect of varied calcium formulations and time of application on postharvest quality and organoleptic acceptability of mango fruits

Abstract

Mango (*Mangifera indica* L.) is a highly perishable fruit with a short shelf life at ambient conditions, which may lead to post-harvest losses approximated to be 40- 45%. This reduces returns to farmers significantly. The problem is compounded by the fact that most farmers do not have access to cold storage facilities. Nutrient management has been shown to affect postharvest characteristics of fruits. Calcium particularly plays a critical role in cell membrane integrity, tissue firmness and delays lipid catabolism. Previous studies have indicated a deficiency of calcium in some mango growing regions in Kenya. A field study was carried out to determine the effect of varied calcium formulations applied at various stages of growth on mango fruits post-harvest quality and organoleptic acceptability. The study was carried out in Embu County Eastern Kenya during seasons 2017/2018 and 2018 /2019 using "Van Dyke" cultivar, aged approximately 10 years. The experiment was set up in a randomized complete block design with a split-split plot arrangement, three trees per replication, replicated thrice. Three calcium formulations: calcium chloride, calcium nitrate and Easygro™ were applied at rates of 0%, 1.0%, 1.5% and 2.0% at fruit set, 30 days after fruit set and 30 days to physiological maturity. The calcium sources formed the main plots, the timing of application formed the subplots while the rates of application formed the sub-sub plots. Total soluble solids (TSS) and percentage titratable acidity (TA) were assessed at harvest and after 12 days of storage under ambient conditions (25±2ºC, 70±5% relative humidity) using standard procedures. Selected fruits' sensory attributes were also evaluated after storage using a hedonic scale. Analysis of data was done using the 14th Edition of the Genstat software. The differences among the means of the treatments were compared using Fisher's Protected LSD test at 5% probability level. Fruits sprayed with calcium chloride, 2.0% at fruit set had higher TSS (6.8 ° brix and 6.3° brix) (10.47 ° brix and 9.10 ° brix), TA (1.29% and 1.27%), (0.77% and 0.675%) than other treatments at maturity and after storage in both seasons, respectively. Calcium chloride at 2.0% level of application led to a superior peel color appearance contrary to calcium nitrate and Easygro™ also applied at 2.0%, which led to an inferior peel color appearance and an inferior taste of fruits. Therefore, calcium nitrate and easy gro should be sprayed at concentration of 1.5% for good taste and peel colour appearance.

Key Words: Mango, total soluble sugars, total titratable acidity, organoleptic, shelflife

iCB 2024-79

Application of state diagrams to understand the nature and kinetics of (bio) chemical reactions in dry common bean seeds: A scientific guide to establish suitable postharvest storage conditions

*Wainaina, I., **Wafula, E.**, Kyomugasho, C., **Sila, D.**, & Hendrickx, M. (2023). Food Research International, 113418.*

Abstract

Storage is a fundamental part of the common bean postharvest chain that ensures a steady supply of safe and nutritious beans of acceptable cooking quality to the consumers. Although it is known that extrinsic factors of temperature and relative humidity (influencing the bean moisture content) control the cooking quality deterioration of beans during storage, the precise interactions among these extrinsic factors and the physical state of the bean matrix in influencing the rate of quality deteriorative reactions is poorly understood. Understanding the types and kinetics of (bio)chemical reactions that influence the cooking quality of beans during storage is important in establishing suitable storage conditions to ensure quality stability. In this review, we integrate the current insights on glass transition phenomena and its significance in describing the kinetics of (bio)chemical reactions that influence the cooking quality changes during storage of common beans. Furthermore, a storage stability map based on the glass transition temperature of beans as well as kinetics of the main (bio)chemical reactions linked to cooking quality deterioration during storage was designed as a guide for determining appropriate storage conditions to ensure cooking quality stability.

Key Words: Glass transition, Cooking quality, Ageing, Mobility, Storage stability

iCB 2024-80

Nutritional and antinutritional characteristics of two biofortified bean varieties grown in Kenya

*Ritho, A. W., **Sila, D. N.**, & **Ndungu, Z. W.** (2023). Current Research in Nutrition & Food Science, 11(2).*

Abstract

The introduction of biofortified bean varieties has brought attention to their potential as a source of high iron and zinc content. This study aimed to investigate the nutritional composition and antinutrient content of two biofortified bean varieties in Kenya, namely Angaza and Nyota.The Proximate composition and mineral content were analyzed using standard AOAC procedures. HPLC analysis was used to determine the Phytic acid content, and the vanillin-HCL method to analyze tannins. The two bean varieties had no statistically significant difference ($P > 0.05$) in carbohydrate content, with Nyota beans at 63.21% and Angaza beans at 61.67%. However, Nyota beans exhibited significantly higher protein content (19.97%) compared to Angaza beans (18.88%) with ($P < 0.05$). While Nyota beans had lower crude fiber (3.65%) compared to Angaza beans (4.78%), the variety showed significantly higher crude fat content (3.23%) than Angaza (1.55%). Both varieties had similar levels of crude ash, i.e., Nyota 3.29%, and Angaza 3.35%. Nyota beans demonstrated higher Iron and Zinc levels, i.e., 5.36 mg/100g and 2.77mg/100g respectively, compared to Angaza beans, 5.07 mg/100g Iron and 2.30 mg/100g Zinc. Nyota beans showed significantly lower levels of phytic acid, i.e., 2.53 mg/g and tannins 2.32 mg/g. The study found no significant statistical difference in the

nutritional characteristics of the two varieties. However, the Nyota had higher protein, fat and mineral content, and lower levels of phytates and tannins. Thus, this study concludes that Nyota could have potential nutritional advantages over the Angaza variety.

iCB 2023-81

How worried are you about food fraud? A preliminary multi-country study among consumers in selected Sub-Saharan African countries

Abstract

Food fraud is an old, recurring, and global threat to public health. It poses a serious threat to food security in sub-Saharan Africa (SSA). Despite the prevalence of food fraud in SSA, little is known about how food fraud is viewed by consumers. This study aims to provide an overview of consumers' concerns about food fraud in SSA. A multi-country survey was conducted in October 2022–31 January 2023, and 838 valid responses were returned. To reduce the large and correlated dataset, Principal Component Analysis (PCA) was used. Five components were derived from PCA: (i) Staple foods; (ii) Premium food and drink products; (iii) Trust in reliable sources; (iv) Trust in less reliable sources; and (v) Trust in food vendors. The findings revealed Ghanaian (mean rank = 509.47) and Nigerian (mean rank = 454.82) consumers tended to score higher on the measure of food fraud concern suggesting that they were less confident in the safety and quality of the food they consume. Demographic characteristics including age, number of children, personal and family experience of food fraud and PCA components such as 'Staple foods', 'Trust in reliable sources', and 'Trust in food vendors' significantly predicted the model. This is the first preliminary study to provide empirical findings on consumers' concerns about food fraud in SSA. Practical and policy recommendations for the region are suggested. This includes (i) modelling the AfriFoodinTegrity in West Africa across other major regions such as Central, East, and Southern Africa; (ii) establish a regional sub-Saharan Africa Rapid Alert System for Food and Feed (SSARASFF) platform; and (iii) food safety and food fraud reports could be incorporated into SSA-RASFF portal for information sharing.

iCB 2023-82

Identification of fungal pathogens causing postharvest rot of bulb onions (*Allium cepa* L.) in selected major growing regions of Kenya

Abstract

Rot is a major cause of bulb onion losses in Kenya, accounting for about 14 % of total postharvest losses. In Kenya, the fungi associated with bulb onion postharvest rot of onion postharvest rots are

not well known. Therefore, this study aimed at identifying the fungal pathogens contributing to bulb onion postharvest rot in major growing regions of Kenya. Bulb onion samples were collected from seven major markets and isolates were obtained by cutting 3 mm tissue segments from the edges of rotten lesions. These were cultured in water agar followed by incubation for seven days at room temperature (23 ± 3°C). After seven days, mycelia plugs from the growing edge of each colony were sub-cultured in potato dextrose agar and incubated for ten days. A total of fifty fungal isolates were obtained from the isolations and in vitro pathogenicity test was done on bulb onions. Eighteen fungal isolates that turned out to be pathogenic were inoculated in bulb onions to assess their level of virulence by measuring lesion size after 21 days of incubation at room temperature (23 ± 3 °). The fungal isolates caused statistically ($P < 0.001$) different sized lesions, ranging from 0.4 ± 0.1 cm to 2.6 ± 0.5 cm. Based on morphological characteristics the eighteen fungal pathogenic isolates were identified as *Fusarium* spp. and were grouped into three clusters. Molecular technique confirmed the three *Fusarium* spp. clusters as *Fusarium oxysporum* f.sp. *cepae* (55 %), *F. acutatum* (17 %) and *F. solani* (28 %). *F. oxysporum* f.sp. *cepae* was predominantly isolated from bulb onions collected in Bungoma County, while *F. solani* was mainly obtained from samples in Kajiado County and *F. acutatum* on bulb onions from Meru County. This study indicates that these three *Fusarium* species are the main fungal species causing postharvest rot in the major bulb onion growing regions of Kenya. Application of appropriate postharvest technology such as curing before storage would minimize postharvest rot in bulb onion.

Key Words: Fusarium, molecular, morphological, pathogenic, postharvest losses

iCB 2024-83

Functional and microstructural characteristics of chitin extracted from field cricket, house cricket, and black soldier fly cocoons
Ndiritu, A., **Kinyuru, J., Onyango, A.***, & Kipkoech, C. (2023). Journal of Food Measurement and Characterization, 17(6), 5903-5912.*

Abstract

Chitin from crustaceans is used in food, pharmaceutical, medical, agricultural and environmental sectors. Edible insects' chitin is an untapped resource since edible insects have a high biodiversity and considerable amounts of chitin. Therefore, this study aimed at characterizing the functional properties and microstructure of chitin extracted from House cricket (*Acheta domesticus*), feld cricket (*Gryllus bimaculatus*) and black soldier fly cocoons (*Hermetica illucens*) and compared with shrimp chitin (commercial). Chitin was chemically extracted and the functional groups were determined by Fourier Transform Infrared Spectroscopy (FTIR). Solubility, emulsion capacity, Water Holding Capacity, Fat Binding Capacity, degree of deacetylation and purity of the extracted chitin were also determined. Based on the FTIR spectra the extracted chitin showed the characteristic functional groups i.e. O–H stretch, C=O stretch, N–H bend, CH2 ending and CH3 deformation, C–N stretch and C–O–C stretch. Chitin extracted from *Gryllus bimaculatus* recorded the highest values in fat absorption capacity (780.14%), emulsion capacity (65.67%) and emulsion stability (65.67%). Chitin extracted from, *Acheta domesticus* was more soluble in water as compared to the commercial chitin. The highest level of deacetylation was reported in *Hermetia illucens* chitin (66.2%) while *Acheta domesticus* chitin had the least value (47.1%). The commercial chitin and *Gryllus bimaculatus* had the highest values for purity followed by *Hermetia illucens*. The microstructure images showed

presence of pores and fbers in all the chitin samples. In conclusion, the insect chitin had characteristics similar to commercial chitin and are thus a suitable alternative in industrial application.

iCB 2023-84

Endogenous ozone as a regular reactive oxygen species in (patho) physiology

Abstract
Inhalation of tropospheric ozone increases the risk of respiratory diseases and the metabolic syndrome (MS). On the other hand, medical ozone therapy is used in the management of many chronic diseases including components of MS. However, medical ozone has not gained universal acceptance because the mechanisms involved therein are not fully understood. Ozone has also been reported to be endogenously formed in cells and organisms. Like medical ozone, endogenous ozone has not been fully embraced, due to limited understanding of the mechanisms of its formation. This review seeks to improve our understanding of the mechanisms of endogenous ozone formation by outlining previously proposed mechanisms, and suggesting new pathways based on reactions that have been reported to be involved in tropospheric ozone formation and electrochemical ozone production from water. New perspectives on the mechanisms of the harms of ozone inhalation and the benefits of medical ozone are discussed. It is hypothesized that endogenous ozone is involved in the harmful effects of particulate matter and ozone inhalation, as well as the benefits of medical ozone, nutraceuticals and physical activity. Thus, endogenous ozone should be regarded as a mainstream reactive oxygen species in redox biology.

1.2. Compilation of Abstracts from iPIC Subtaskforce

iPIC 2023-01

Experimental Investigations of the Effects of Secondary Air Injection on Gaseous Emission Profiles (NOx, NO, NO2, CO) and Hydrocarbons (CxHx) in Cookstoves Using Charcoal from Eucalyptus glandis
Paul Njogu, Purity Muthoni, Peter Oketch, Daniel Omondi, Elijah Ngumba

Abstract
Use of biomass in domestic cookstoves leads to the release of oxides of nitro-gen (NOx), nitric oxide (NO), nitrogen dioxide (NO2), carbon monoxide (CO) and hydrocarbons CxHx that can be detrimental to health of the public and the environment. Attainment of complete combustion is the best strategy for mitigating the release of these emissions. This study sought to experimentally determine the effects of secondary air injection on the emission profiles of NOx (NO & NO2), CO and CxHx in a charcoal operated cookstove. Charcoal from Eucalyptus glandis was bought from

Kakuzi PLC. Composites from three batches were analyzed for chemical composition and the stoichiometric air equivalent. Proximate analysis data show that the charcoal composed 58.72% ± 3.3% C, 15.95% ± 1.2% Volatile Matter, 4.69% ± 0.55% Moisture, 20.7% ± 0.8% Ash, High heat value (HHV) of 30.5 ± 1.1 and 29.3 ± 1.3 Low heat value (LHV) (MJ/kg) with a chemical formula of C18H2O and a stoichiometric air requirement of 5.28 ± 0.6 3 m air h N with a fuel flow rate of 1 kg fuel/hr. Emission profiles for CO and CxHx reduced significantly by 70% and 80% respectively with secondary air injection whereas those of NOx increased by between 15% and 20% for NO2 and NO. The study reveals that secondary air injection has potential to mitigate on emission release, however other measures are required to mitigate NOx emissions.

Key words; Biomass, Stoichiometric, Emissions, Combustion, Pollution, HAP, Cookstoves.

Numerical and Experimental Investigation of Fluidized Bed Hydrodynamics at Elevated Temperatures

Fredrick Njuguna, *Hiram Ndiritu, Benson Gathitu, Meshack Hawi, Jotham Munyalo*
International Journal of Engineering Research in Africa (Volume 64-2023); https://doi.org/10.4028/p-a41tm2

Abstract:
Fluidized bed gasifiers operate at elevated temperatures, and experimental measurements for the hydrodynamic parameters at high temperatures are difficult and time consuming, making computational fluid dynamics simulation useful for such investigation. In this study, Opensource computational fluid dynamics code, OpenFOAM, was used to investigate temperature effect on the fluidized bed hydrodynamics on a 3D fluidized bed model using Eulerian-Eulerian approach. Silica sand of particle sizes of 500, 335 and 233 μm was used as the bed materials under temperatures between 25 and 400 °C. To validate the simulation model, a laboratory scale fluidized bed unit was used to conduct experiments for the same range of temperature and sand particle sizes. The results revealed that the temperature of the bed materials greatly affect fluidized bed hydrodynamics. The minimum fluidization velocity increased with the sand particle diameter but decreased with the temperature. On the other hand, the bed porosity at the minimum fluidization point increased marginally with both the temperature and the particle size of the bed materials. Further analysis showed that the expanded bed height increased with the temperature for a specific superficial velocity while the bubbles grew in size with both the air flow rates and the temperature. The numerical model results were compared with the experimental results based on minimum fluidization velocity, bed porosity and pressure drop at the minimum fluidization point. The hydrodynamic results of the numerical model were in good agreement with the experimental results.

Keywords: Computational Fluid Dynamics, Fluidized Bed Hydrodynamics, Gasifier, OpenFOAM

Experimental investigation and optimization of the gasification parameters of macadamia nutshells in a batch-fed bubbling fluidized bed gasifier with air preheating

Fredrick Irungu Njuguna a, Hiram M. Ndiritu a, Benson B. Gathitu b, Meshack Hawi a, Jotham Muthoka Munyalo

Abstract

Gasification of biomass waste has a significant potential to reduce environmental impact and promote sustainability by producing syngas, which is considered as renewable energy. This work investigated the gasification of macadamia nutshells in air-preheated, batch-fed fluidized bed gasifier. The study conducted a parametric analysis to assess the effect of equivalence ratio (ER) and air temperature on the gasifier temperature profile and its performance based on gas composition, higher heating value (HHV), and gas yield. The research was conducted within the range of 0.15–0.35 for the ER and 25–825 °C for the air temperature. Multi-objective numerical optimization was conducted using response surface methodology (RSM). From the parametric study, a distinct temperature profile was observed along the gasifier height, with the peak temperature near the top of the fluidized bed section and the lowest temperature at the top of the gasifier. Air preheating mostly favored gasification temperature at the lower part of the gasifier and showed rare significance at the top. No improvement in gasifier performance was observed beyond an air temperature of 620 °C, which was identified as the ideal air-preheating temperature. Analysis of variance (ANOVA) revealed that the ER was the most influential parameter in the production of combustible gasses, syngas HHV and gas yield. Air preheating did not have a significant effect on methane production and gas yield. The most optimal values for ER and air temperature were obtained as 0.195 °C and 620 °C, respectively, producing optimal values of 9.54, 14.65%, 2.03, 4.02 MJ·Nm−3, and 1.82 Nm3·kg−1 for hydrogen, carbon monoxide, methane, HHV, and gas yield, respectively.

Effect of pyrolysis temperature on the physiochemical properties of biochar and its potential use in anaerobic digestion: A critical review

Mohammad Javad Bardi, Jackline M. Mutunga, Hiram Ndiritu, Konrad Koch

Abstract

A comprehensive study was conducted to assess the influence of pyrolysis temperature (PyT) on the properties of biochar (BC) and its potential application in anaerobic digestion (AD). PyT is an essential parameter for effectively utilizing BC in full-scale AD, because PyT can develop BC properties that are necessary for improving AD performance through (I) the increment of BC porosity, (II) the adsorption and conversion of metabolites, (III) the enrichment of microbial communities, and (IV) the enrichment of functional groups. Some features of BC, such as porosity, electrical conductivity, and pore structure, increase consistently with increasing PyT. These properties have a positive effect on AD and enhancement of methane yield. The adsorption of excessive metabolites correlates with the enrichment of BC functional groups. The appearance of functional groups of BC decreases when the PyT increases. No substantial correlation ($R2 < 0.1$) could be found between the enhancement of methane yield and the enrichment of BC functional groups and the adsorption

capacities of BC. Microbial communities are positively correlated to the increment of PyT with a moderate correlation (R2 = 0.33) to the enhancement of methane yield. The review also identifies several knowledge gaps that necessitate further investigation. © 2023 The Author(s). Published by Elsevier B.V. This is an open access article under the CC.

iPIC 2023-05

Kinetic modeling and optimization of process parameters for gasification of macadamia nutshells with air preheating: A combined use of Aspen Plus and response surface methodology (RSM)
Fredrick Njuguna, Hiram Ndiritu, Benson Gathitu, Meshack Hawi, Jotham Munyalo
Bioresource Technology Reports; volume 22, https://doi.org/10.1016/j.biteb.2023.101477

Abstract

This study used Aspen Plus process simulation for sensitivity analysis to identify the range of parameters for subsequent optimization using response surface methodology, to maximize syngas combustible gases and higher heating value (HHV) while minimizing tar. From the analysis of variance, equivalence ratio (ER) was the most significant parameter affecting H_2 and CH_4 production, HHV and tar content while pressure contributed the least. Air temperature influenced CO production the most while ER had the least effect. For a pressurized gasifier operating at 4 atm, optimal ER and air temperature was 0.16 and 575 °C respectively, producing syngas with HHV and tar content of 4.3 MJ/Nm^3 and 23.68 g/Nm^3 respectively. Optimal ER and air temperature for atmospheric pressure gasifier were 0.15 and 445 °C respectively, resulting in syngas with HHV and tar content of 4.14 MJ/Nm^3 and 29.17 g/Nm^3 respectively. The simulation results were in good agreement with the experimental data.

iPIC 2023-06

Failure analysis of corroded heat exchanger CuNi tubes from a geothermal plant
Joseph B. Morake, James M. Mutua , Martin M. Ruthandi, Eyitayo O. Olakanmi, Annelize Botes
Engineering Failure Analysis; https://doi.org/10.1016/j.engfailanal.2023.107543

Abstract

This study examined the premature failure of cupronickel (CuNi10Fe) tubes in a shell-and-tube heat exchanger after five months of service. An investigation to identify the root cause of the tube burst was carried out using macroscopic and microscopic inspection, chemical analysis, and mechanical analysis. The optical microscopy (OM) and scanning electron microscopy (SEM) evaluation revealed crack propagation characterized by pits and inclusions at the tube surface. This was due to the diffusion of hydrogen ions into the material from the hydrogen sulfide (H_2S) rich geothermal environment. Furthermore, high tensile residual stresses of 172 MPa were recorded in the failed tube, leading to stress cracking in hydrogen-containing material. Additionally, the high sulfide content in corroded water and condensate samples suggests that the leading cause of tube rupture was through hydrogen embrittlement and sulfide stress cracking mechanism in the presence of hydrogen sulfide. Therefore, the use of laser cladding to protect tubes using functionally graded materials is

recommended to mitigate degradation in aggressive environments, through careful material selection and additional water treatment to eliminate the contaminants.

iPIC 2023-07

Integrated Taguchi and response surface methods in geometric and parameter optimization of PEM fuel cells

Christabel C. Ngetich, James Mutua, Patrick Kareru, Kabini Karanja, Evan Wanjiru
Fuel Cells Wileys; https://doi.org/10.1002/fuce.202200209

Abstract

Proton exchange membrane (PEM) fuel cell has emerged as a promising alternative to fossil fuels as it is employed to generate electricity for portable applications with low carbon emissions. However, the high cost of the technology hinders its widespread commercialization. Optimizing PEM fuel cell model parameters is crucial in performance improvement and production cost reduction. This study presents an optimization approach for a PEM fuel cell operating and design parameters by integrating Taguchi and Response Surface Methodology. A 3D-CFD model of a PEM fuel cell is developed and used as a base model for the optimization study. Thirteen input parameters with notable effects on the fuel cell's performance are selected for this study. By the Taguchi method, these parameters decreased from thirteen to five. A response surface methodology (RSM) Box-Behnken experimental design is employed to study the interactions of the parameters on the power density. The optimum working parameters that result in optimum power density of 0.8476 W cm^{-2} include an operating pressure (2.5 bar), temperature (80°C), flow channel width (1.30 mm), membrane thickness (0.036 mm), and catalyst layer thickness of 0.01 mm. This study provides a quick and efficient way of optimizing PEM fuel cell model for maximum power density.

iPIC 2023-08

Modelling and Simulation of Composition and Mechanical Properties of High Entropy Magnesium-based Multicomponent Alloy

Robert Otieno, Edward V. Odhong, James MutuaAdvances in Materials Science and Engineering: An International Journal (MSEJ),Vol. 10, No.1/2/3, September 2023

Abstract

Magnesium alloys are high potential materials for application in the aerospace and automotive industries due to their lightweight properties. They can help to lower dead weight and fuel consumption to contribute to sustainability and efficiency. It is possible to achieve high specific strength and high stiffness of the alloys by varying compositions of alloying elements. Applications of magnesium are limited due to its low strength and relatively low stiffness. This research focuses on a recipe of multicomponent alloys of magnesium with varied percentages of Mg, Al, Cu, Mn and Zn obtained from literature and optimizes the percentage compositions to obtain high specific strength and specific stiffness. Relationships among percentage constituents of the alloy components are examined in Matlab R2022b using multiple linear regression. Optimization is achieved using genetic algorithm to determine the specific strengths and stiffness. The resulting optimal alloy component percentages by weight are used for microstructure simulation of thermodynamic properties, diffusion and phase transformations of proposed alloy is done in MatCalc software version 6.04. Results show potential for improved mechanical properties resulting from disordered structure in the high entropy

magnesium alloy. Future research should focus on production and characterization of the proposed alloy.

iPIC 2023-09

Determination of the utility of endometrial Tao brush in the detection of endometrial cancer and atypical hyperplasia
E.J. Kemei, E.J. Cheserem, M. Mungania, J. Mutua, C.M. Kyama, East African Medical Journal / Vol. 100 No. 9 (2023)

Abstract
Background: Endometrial cancer is among the most common gynecologic malignancies in Kenya as it is in other developing countries. Screening using the Tao brush for direct sampling of the endometrium is a reliable technique for detecting lesions and can be done in an outpatient setting. These attributes enable early detection which is crucial for favorable outcomes, as over 90% of patients with early stages of endometrial cancer can be cured with treatment.
Objective: To determine the Utility of Endometrial Tao brush in the detection of endometrial malignancies.
Design: Prospective Cross-sectional Study.
Setting: Department of Laboratory Medicine, Kenyatta National Hospital and Department of Obstetrics and Gynaecology, Kenyatta National Hospital.
Study setting: Kenyatta National Hospital (KNH) gynecology Clinic.
Measurable Variables: Independent variables included demographic and clinical data including; age, early menarche, late menopause, obesity, parity, and hypertension. Dependent variables included histopathological parameters of lesions; tumor size, type, tumor invasion, and metastasis.
Results: Sixty women fulfilled the study entry criteria and were evaluated. Histopathological diagnoses comprised of; 14 (23%) Endometrial Cancers, 8 (13%) Complex hyperplasia with atypia, 16 (27%) Simple and mild hyperplasia without atypia, 3 (5%) Non- Diagnostic, and 19 (32%) patients with Negative Endometrial Histology. The specificity and sensitivity of cytology using Tao Brush were 100% and 95.45% respectively. The kappa value was 0.912.

Conclusions: This study shows that endometrial Tao brush had a high specificity and sensitivity with a nearly perfect agreement with the dilatation and curettage samples. It therefore could have utility in most clinical settings in Kenya.

iPIC 2023-10

Optimization of polygonal cross-sectioned conformal cooling channels in injection molding
Laura W. Simiyu, James M. Mutua, Patrick I. Muiruri & Bernard W Ikua,
International Journal on Interactive Design and Manufacturing (IJIDeM),2023, 18(3):1-17, DOI:10.1007/s12008-023-01226-7

Abstract
In injection molding process, cooling time accounts for up to 80% of the whole cycle time, and this has a significant effect on productivity. Cooling time can be reduced by use of cooling channels in molds. This paper presents a study on optimization of conformal cooling channels with various cross-

sectional shapes, depths, and pitches. The depth of sink marks, volumetric shrinkage, warpage, and cooling time, are estimated using Solidworks Plastics 2021® using Taguchi design of experiments. Simulations on cooling time were carried out for a mold with straight cooling channels and experiments were carried out to verify the simulation results. Simulations were then carried out on molds with conformal cooling channels and the results were analyzed using Analysis of variance, principal component analysis, and grey relational analysis. It is seen that the multi-response Taguchi-Grey optimization method is suitable for the selection of the best cooling channel design. It is further seen that the shortest cooling time with smallest product defects can be achieved through the use of a cooling channel with a decagonal cross-section and a depth equal to the pitch. Moreover, pitch is the most critical factor influencing sink marks, shrinkage, warpage, and cooling time concurrently.

iPIC 2023-11

The potential use of laser cladded functionally graded materials to mitigate degradation in boiler tube heat exchangers for power plant applications: A review

Joseph B. Morake, James M. Mutua and Eyitayo O. Olakanmi

Abstract

Surface modification is essential to safeguard heat exchangers from premature failure spurred by deterioration mechanisms such as corrosion and wear, which diminish performance. Meanwhile, modifying some substrates with dissimilar materials is challenging due to a mismatch in material properties. Moreover, individual alloy coatings on substrates are usually insufficient in the required material properties, leading to accelerated failure of equipment, especially in power plant industries. This article summarised the knowledge base on functionally graded materials (FGMs) while emphasising how this promising class of novel materials can reduce deterioration. Additionally, laser cladding is established to be a suitable technique for processing FGMs. A particular focus is laid on the laser beam interaction with the FGM and expounding on the processing and material parameters that affect the microstructural properties of FGMs. The development prospects for processing FGMs with superior clad quality characteristics to increase boiler pipes' service life and performance are also highlighted.

iPIC 2023-12

Exergetic optimisation of a solar-biomass hybrid greenhouse dryer in drying banana slices

Florence G. Kiburi, **Erick K. Ronoh**, *Christopher L. Kanali, Gareth M. Kituu and Patrick O. Ajwang*

Abstract

In this study, an elitist non-dominated sorting genetic algorithm was applied in exergetic optimisation of a solar-biomass hybrid greenhouse dryer in drying banana slices. To develop comprehensive relationships for objective functions under each drying mode (solar, biomass, and solar-biomass), the system was linearised around drying and exit air temperatures. The objective functions involved maximising exergy efficiency and drying air temperature of the system. The trade-offs showed that solar and solar-biomass modes required the same airflow rate (0.05 kg/s) indicating that at these combinations the dryer received almost equal energy input. Biomass mode trade-offs indicated that a lower flow rate (0.01 kg/s) was required for drying. Further, both solar-biomass and biomass modes

must maintain a fuel feed rate of 0.001 kg/s for maximum exergy efficiency (solar-biomass: 80.21% ± 14.26%; biomass: 79.28% ± 10.38%) and drying air temperature of 333 K. Performance evaluation of the optimised system demonstrated its superiority compared to the unoptimised system.

iPIC 2023-13

Finite element based model for predicting induced residual stresses and cutting forces in AISI 1020 steel alloy

R. N. Bosire, O. M. Muvengei, J. M. Mutua, J. K. Kimotho,

Abstract

The application of finite element models is a promising method for ensuring part quality during machining to accurately predict induced residual stresses and cutting forces. The present study applied Analysis System software to formulate a 3D model to predict induced residual stress and forces for AISI 1020 alloy. Taguchi method was applied in the design of the experiment with three levels and three factors selected: Cutting speed, feed rate and depth of cut. For validation, stresses are measured using an x-ray diffractometer from the surface to a depth of 0.6 mm in steps of 0.2 mm. The cutting forces are determined using a force dynamometer. Simulation results showed that cutting speed, feed rate and depth of cut contributed 94.76 %, 0.048 %, and 0.11 % respectively. The predictive model equations were statistically significant with a p-value of <0.005. The average induced residual stress on the superficial layer from the experiment and simulation were -367.7 MPa and -365.6 MPa respectively. The average residual stresses obtained at depths of 0.2 mm, 0.4 mm, and 0.6 mm were -260 MPa, -233 MPa, and -211 MPa, respectively. The proposed model offers a potential solution to reducing the costs of experimental methods.

iPIC 2023-14

Development and Evaluation of Recycled Polypropylene and Bean Pod Powder Composite Biomaterial for Fused Filament Fabrication

Felix Sotohou, James W. Mwangi, James M. Mutua, Erick K. Ronoh

Abstract

Approximately 450 million tons of plastic and agricultural waste are produced each year in the world. Only a small portion of this plastic waste is recycled, and a small portion of this agricultural waste is used as fuel or fertilizer, and the rest of this waste is left in the environment or is burned, resulting in environmental and air pollution. For proper disposal, plastic and agricultural waste can be used in the manufacture of composites as raw materials. In this study, we had evaluated the use of bean pod powder (BPp) was used as natural reinforcing filler in recycled polypropylene (rPP) based composites. BPp/rPP composite filaments were developed using the extrusion method and the samples were printed by Fused Filament Fabrication (FFF). Composites with rPP matrix containing

different weight fractions of BPp (5%, 10% and 15%) were fabricated to observe and compare the mechanical properties (tensile, flexural, and compressive strength) of the filament composites. In addition, the filament surface was analyzed for roughness and particle size of bean pod powder. The results established that BPp/rPP composites exhibited better tensile, flexural, and compressive strength than rPP and pure PP. By adding 5 wt% BPp, the tensile strength of rPP increased from 20.4 MPa to 22.8 MPa. The highest flexural strength (15.05 MPa) was obtained at 5 wt% BPp among all composites and the highest compressive strength (24.5 MPa), was obtained at 10 wt% BPp. Therefore, it can be concluded that by carefully selecting the ratio of BPp to bean pod powder, it is therefore possible to positively influence the mechanical properties of the resulting composite.

Keywords: Pollution, Composite, Fused Filament Fabrication, Mechanical Properties

iPIC 2023-15

Simplified shear equation of deep concrete beam considering orientation effect of opening and mechanical properties of fibre-concrete interface

Daudi Salezi Augustino, Christopher Kanali, Richard Ocharo Onchiri, Charles Kabubo, Heliyon 9 (2023), https://doi.org/10.1016/j.heliyon.2023.e14441

Abstract

In the present era of technology, the design of structural deep concrete beams is highly modernized through the use of computer-aided tools. However, theories for such design are the paramount aspects to be understood particularly when the beam has openings. To improve the mechanical properties of the deep beam with openings, recycled tyre steel fibres are required. To estimate the bond strength of the fibre-concrete interface, the concrete shrinkage strains for fibre lengths 30, 50 and 60 mm with a content of 0.5% were considered. To mitigate the conservativeness of some available shear models and improve the design of deep beams, the simplified shear equation model was developed. The model was established using a simplified compressive stress block, forces in steel reinforcement and shear stress at the fibre-concrete interface. The combined effect of opening height and length was also considered in the model. The results show that incorporating fibres in concrete increase the shear performance of deep concrete beams with openings due to high strains in the shear zone indicating high loads being transferred. For instance, beam BS2 had a strain of 0.0153 in the lower load path compared to 5.6×10^{-5} for beam BC2 There was a good correlation between measured and proposed shear capacities with t-test values of 0.46, 0.996 and 0.003 for beams without fibres, and with fibres and mesh respectively. Results also showed the model shear equation performed better compared to other equations with mean absolute error (MAE) and coefficient of variation (COV) of 9.3 and 18.9%, respectively for the control beams with openings. The model also showed a mean absolute error (MAE) and coefficient of variation (COV) of 11.6 and 7.4%, respectively for the beams with fibres. The COV and MAE for the proposed model were small than those in the database, therefore, the proposed model can provide the precise design of deep concrete beams with openings and fibres.

Keywords: Deep concrete beam; Fibre-concrete interface; Internal strengthening; Shear capacity; Simplified shear equation.

iPIC 2023-16

Optimization of laser-cladded SS316L/IN625 functionally graded material deposited on a copper substrate for boiler pipe heat exchanger applications

Joseph B. Morake, Martin R. Maina, James M. Mutua, Eyitayo O. Olakanmi & Sisa L. Pityana

Abstract

Laser cladding is a surface modification method that can be employed in components under severe operating conditions, such as boiler heat exchangers, to mitigate degradation. However, poor clad quality hinders performance during service. This study employed the hybrid Taguchi-grey relational analysis and artificial neural network (ANN) method to optimize the clad qualities while varying the laser cladding process parameters including laser power, scanning speed, and powder flow rate. Laser cladding process parameters were used in the backpropagation NN model as input, and the grey relational grade was employed as the output of the model to improve the clad properties. The values of performance attributes for microhardness and aspect ratio were increased, whereas surface roughness and porosity were reduced in the fabricated functionally graded stainless steel 316L/Inconel 625 coating. When the ANN model was used to optimize the experimental grey relational analysis conditions, it was found that the 600 W laser power, 700 mm/min scanning speed, and 1.5 g/min powder flow rate enhanced the experimental output. The generated model significantly improved the quality of the laser cladding process. A confirmatory experiment was carried out using ANN optimal parameters, and the fabricated samples were subjected to microscopic analysis to ascertain the influence of process parameters on clad characteristics. Heat treatment was also used to alleviate the tensile residual stresses of the fabricated functionally graded material. Thus, the ANN model and fabricated coating can be utilized effectively to modify the boiler pipe surface.

iPIC 2023-17

Control Environment and Control Activities Internal Control Systems and Management of Local Revenue by County Governments of Kenya

Ayao Evans Onsindu, Prof. Willy Muturi, Prof: Christopher Kanali
Abstract

An adequate and effective internal control system is necessary for better organizational performance. Studies show that an effective internal control mechanism prevents and detects fraud which then enables management to take necessary steps to remedy the situation. This study attempted to examine the effect of internal control systems on the management of local revenue by the county governments of Kenya. The study was guided by the COSO (1992) integrated framework. The two components of the internal control system framework included in the study were the control environment and control activities. Statistical data was collected by a COSO questionnaire that was adapted for use in public entities. The County Chief Officers for finance from all counties provided information on the adequacy and effectiveness of their internal controls respectively. Data was processed and analyzed using descriptive statistics such as frequencies, percentages, mean and standard deviation and inferentially using correlation and regression analysis to describe characteristics and show relationships that predict effective management of revenue in county governments. The hypotheses were tested statistically at the 0.05 level of significance. There was a significant positive relationship

between the internal control environment and the management of local revenue. There was also a significant positive relationship between internal control activities and the management of local revenue. The county governments should also ensure that their organizations have a strong internal control environment where internal control activities inform policies and procedures that are adequate.

iPIC 2023-18

Effects of teff straw ash on the mechanical and microstructural properties of ambient cured fly ash-based geopolymer mortar for onsite applications

Tajebe Bezabih, Christopher Kanali, Joseph Thuo

Abstract

Although geopolymer cement (GPC) is a substitute for Portland cement, its application is restricted due to the need for high-temperature curing (40–90 °C), which makes it challenging to utilise for onsite applications. To address this issue, the current study examined the potential of substituting fly ash (FA) with teff straw ash (TSA) in geopolymer mortars cured at ambient temperature. The findings revealed that substituting FA with TSA can eliminate the need for high-temperature curing, and the compressive strengths of FA-TSA-based geopolymer mortar mixtures cured for 28 days ranged from 45 to 53 MPa. Further, increasing the TSA content enhanced the mortar's flexural and direct tensile strengths. A teff straw ash level of 10% increased compressive, flexural, and direct tensile strengths by 40%, 59%, and 30% at 28 days, respectively. Furthermore, the mineralogical phases of the mortar after 28 days confirmed the presence of gismondine coexisting with other phases, and microstructural analysis indicates that the inclusion of TSA resulted in a denser structure. These findings suggest that TSA could be a potential substitute for FA in GPC applications to lower energy usage and environmental impact.

iPIC 2023-19

Performance enhancement and emissions reduction in a diesel engine using oleander and croton biodiesel doped with graphene nanoparticles

Treza Wambui, Meshack Hawi, Francis Njoka, Joseph Kamau

Abstract

Biodiesel is considered a suitable substitute for petroleum diesel because it is renewable, environment-friendly, and has a low carbon footprint. However, its high density, high viscosity and low heating value prevents it from replacing petroleum diesel completely. This study investigates the performance and emission characteristics of a compression ignition engine operating on oleander and croton biodiesel doped with graphene nanoparticles. Five fuel samples are used, including diesel

(D100), diesel - 80% blended with oleander and croton biodiesel - 20% (OCB20) and OCB20 dosed with graphene nanoparticles at mass fractions of 50 ppm (mg/L), 75 ppm (mg/L) and 100 ppm (mg/L), respectively. The chemical composition of biodiesel and graphene nanoparticles is analyzed using Fourier Transform Infrared (FTIR) spectroscopy while the morphology of the nanoparticles is analyzed using Scanning Electron Microscope (SEM). Engine tests reveal a significant improvement in brake thermal efficiency, especially at 75 ppm concentration which is 2.76% and 18.93% higher than diesel and OCB20, respectively, and a reduction in brake specific fuel consumption by 2.44% and 16.67% compared to diesel and OCB20, respectively. Carbon monoxide (CO) and unburnt hydrocarbon emissions (UHC) decreases for the 50 ppm sample, recording 8.58% and 21.65% reduction in CO and 52.2% and 50% in UHC compared to the diesel and OCB20, respectively. However, Oxides of Nitrogen (NOx) emissions increase. The results indicate that graphene nanoparticle-enhanced biodiesel can adequately substitute petroleum diesel, albeit with NOx reduction techniques.

Keywords: Biodiesel; Compression ignition engine; Emission; Nano additives; Engine Performance

iPIC 2023-20

Biological treatment of agro-processing industrial effluents from tannery, coffee and dairy plants using green algae (*Chlorella Ssp*.) cultured in a photo bioreactor

Jared O. Ondiba, Christopher L. Kanali, Benson B Gathitu

Abstract

Due to increased environmental pollution as a result of high emission rates from agro-processing industries, the effluents must be cleaned up before being released into the environment. This study outlines the use of green algae for nutrient removal from agro-processing effluents discharged from three agro-industries (namely coffee, dairy, and tannery) in Kenya and how they can be used for the propagation of microalgae for biofuel production. Green algae were grown inside a photobioreactor containing the three agro-industrial effluents as nutrient media for 21 days. Thereafter, the algae were harvested and evaluated for biofuel production. The effectiveness of green algae (chlorella ssp) to extract the cations from the various agro-processing effluents was used to gauge how well they performed. Additionally, the algae growth rate, quantity of lipids, and biomass generated were used to evaluate the strains' effectiveness in producing biofuel. The results indicate that the highest maximum algae growth rate of 14.528 mg/mL occurred in the dairy effluent. The corresponding values for the coffee and tannery effluents were 13.016 mg/mL and 10.866 mg/mL, respectively. Biochemical analysis was done to establish the amount of biomass in the algae. The results showed that there was higher biomass productivity per day of 293.944, 124.849, and 91.997 μg/mL for the dairy, coffee, and tannery effluents, respectively. The contents of linolenic acid in the chlorella strain in the dairy, coffee, and tannery effluents were 13.21, 12.86, and 15.98%, respectively. The values obtained were slightly above the recommended lower limit value of 12% (EN 14214, 2004) for the production of quality biofuels. The results further show that high chemical oxygen demand removal (maximum of 47.7–67.8%) and total phosphorus removal (maximum of 95%) were achieved in all three effluents. Finally, the fatty acid methyl ester profiles produced indicated that the lipid content of the cultivated green algae was appropriate for the production of biofuel.

iPIC 2023-21

Control and Monitoring of Amaranth Blitum Growth under Greenhouse Cultivation

K Elysee, R Ndeda, UN Mutwiwa, S Aoki

Abstract

Weather extremes caused by climatic change considerably affect crops growth. Extreme temperature change and low water availability represent undesirable conditions for the growth of amaranth. This study aims to develop a greenhouse equipped with an automatic control system for water, humidity, and temperature control of Amaranth Blitum. Temperature, humidity, and soil moisture were monitored and maintained within a specific range. A microcontroller was used to activate a solenoid for irrigation-based sensor feedback, an exhaust fan, a cooling fan, and a heater to regulate humidity, and temperature respectively. The study was done in the month of July and December 2022. Efficient temperature and humidity control were demonstrated. The increase in plant height and diameter was higher for higher moisture content, a temperature within the 21 - 35°C range, and humidity within 45-95%. This work demonstrated the utility of sensor-based approach for monitoring and controlling of growth of Amaranth under greenhouse cultivation by applying a rule-based algorithm. The results of this research could be implemented to reduce plant damage while increasing yield productivity.

1.3.   Compilation of Abstracts from iCMoB Subtaskforce

iCMoB 2024-01

Synthesis and Characterization of Parthenium hysterophorus-Mediated ZnO Nanoparticles for Methylene Blue Dye Degradation

Dennis Nzilu, Edwin Madivoli, David Makhanu, Sammy Wanakai, Gideon Kirui, Vincent Mwangi, Patrick Kareru

Abstract

Herein, zinc oxide nanoparticles (ZnO NPs) were synthesized using Parthenium hysterophorus whole plant aqueous extract as reducing and capping agents. The synthesized ZnO NPs were characterized via UV-Vis spectroscopy, Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), and dynamic light scattering (DLS). An intrinsic optical absorbance of ZnO NPs occurred at 337 nm in the UV-Vis spectrum. The FTIR analysis revealed the presence of secondary metabolites responsible for reducing and stabilizing the nanoparticles. Furthermore, SEM and TEM images revealed that ZnO NPs were spherical with an average particle size of 38 nm. The XRD analysis revealed that ZnO NPs had a hexagonal wurtzite crystal structure with a crystallite size of 42.6 nm. The synthesized nanoparticles were investigated for degradation ability against methylene blue dye at varying conditions of ZnO NPs' dosage, methylene blue concentrations, pH, temperature, and interaction time. Degradation efficiency of 55.69% was obtained at optimal conditions using 50 mg of ZnO NPs, 5 mg/L of MB dye concentration, and pH 12 and at 65°C within 32 minutes. Due to their novel green

synthesis route, Parthenium hysterophorus-mediated ZnO NPs are promising candidates for removing persistent organic dyes from aquatic environments.

iCMoB 2024-02

Antimicrobial surface coating as a pathway to curb resistance: preparation, mode of action and future perspective

Vincent Ngunjiri Mwangi, Edwin Shigwenya Madivoli, Mourine Kangogo, Sammy Indire Wanakai, Walyambillah Waudo & Dennis Mwanza Nzilu

Abstract

Antimicrobial resistance has proven to be an existential threat that endangers the health of human beings. The ease of accessing conventional antibiotics, and their unlimited and unregulated use and often misuse is seen to be a contributing factor to the rise in the resistance of microbes toward medications. The overuse of these medications in the agricultural sector also adds to the rising burden of antibiotic resistance. In line with efforts to counter the threat of antimicrobial resistance and the menace of hospital acquired infections developing antimicrobial surface coatings that can eliminate microbes that get deposited on those coatings is essential. This review aims to bring an understanding of antimicrobial resistance mechanisms, the preparation and mode of action and the future perspective of the antimicrobial surface coatings.

iCMoB 2023-01

Strain structure analysis of Mycobacterium tuberculosis circulating among HIV negative, positive and drug resistant TB patients attending chest clinics in Western Kenya

Martin O. Ogwang, Lameck Diero, Florence Ng'ong'a, Gabriel Magoma, Lucy Mutharia, Mabel Imbuga & Caroline Ngugi

Abstract

Background

Despite global tuberculosis (TB) interventions, the disease remains one of the major public health concerns. Kenya is ranked 15th among 22 high burden TB countries globally.

Methods

A cross-sectional study was conducted in Western Kenya, which comprises 10 counties. A multistage sampling method was used where a single sub-county was randomly selected followed by sampling two high volume health facility from each sub-county. Identification of spoligotype profiles and their family distribution and lineage level were achieved by comparison with SITVIT database.

Results

Lineage distribution pattern revealed that the most predominant lineage was CAS 220 (39.8%) followed by Beijing 128 (23.1%). The other lineages identified were T, LAM, H, X, S and MANU which were quantified as 87 (15.7%), 67 (12.1%), 16 (2.8%), 10 (1.8%), 8 (1.4%) and 5 (0.9%) respectively. CAS and Beijing strains were the most predominant lineage in both HIV negative and positive TB patients. The Beijing lineage was also the most predominant in resistant M. tuberculosis strains as compared to wild type. A total of 12 (2.0%) were orphaned M. tuberculosis strains which were spread across all the 10 counties of the study site. In multivariate logistic regression adjusting

for potential cofounders three potential risk factors were significant. HIV status (OR = 1.52, CI = 0.29–3.68 and P value of 0.001), Alcohol use (OR = 0.59, CI = 0.43–3.12 and P-value =0.001) and cross border travel (OR = 0.61, CI = 0.49–3.87 and P value = 0.026). Most M. tuberculosis clinical isolates showed genetic clustering with multivariate logistic regression indicating three potential risk factors to clustering. HIV status (OR = 1.52, CI = 0.29–3.68 and P value of 0.001), Alcohol use (OR = 0.59, CI = 0.43–3.12 and P-value =0.001) and cross border travel (OR = 0.61, CI = 0.49–3.87 and P value = 0.026).

Conclusion

There exist diverse strains of M. tuberculosis across the 10 counties of Western Kenya. Predominant distribution of clustered genotype points to the fact that most TB cases in this region are as a result of resent transmission other than activation of latent TB.

iCMoB 2023-02

Determination of the utility of endometrial Tao brush in the detection of endometrial cancer and atypical hyperplasia

E.J. Kemei, E.J. Cheserem, M. Mungania, J. Mutua, C.M. Kyama
East African Medical Journal, Vol. 100 No. 9 (2023):

Abstract

Background: Endometrial cancer is among the most common gynecologic malignancies in Kenya as it is in other developing countries. Screening using the Tao brush for direct sampling of the endometrium is a reliable technique for detecting lesions and can be done in an outpatient setting. These attributes enable early detection which is crucial for favorable outcomes, as over 90% of patients with early stages of endometrial cancer can be cured with treatment.

Objective: To determine the Utility of Endometrial Tao brush in the detection of endometrial malignancies.

Design: Prospective Cross-sectional Study.

Setting: Department of Laboratory Medicine, Kenyatta National Hospital and Department of Obstetrics and Gynaecology, Kenyatta National Hospital.

Study setting: Kenyatta National Hospital (KNH) gynecology Clinic.

Measurable Variables: Independent variables included demographic and clinical data including; age, early menarche, late menopause, obesity, parity, and hypertension. Dependent variables included histopathological parameters of lesions; tumor size, type, tumor invasion, and metastasis.

Results: Sixty women fulfilled the study entry criteria and were evaluated. Histopathological diagnoses comprised of; 14 (23%) Endometrial Cancers, 8 (13%) Complex hyperplasia with atypia, 16 (27%) Simple and mild hyperplasia without atypia, 3 (5%) Non- Diagnostic, and 19 (32%) patients with Negative Endometrial Histology. The specificity and sensitivity of cytology using Tao Brush were 100% and 95.45% respectively. The kappa value was 0.912.

Conclusions: This study shows that endometrial Tao brush had a high specificity and sensitivity with a nearly perfect agreement with the dilatation and curettage samples. It therefore could have utility in most clinical settings in Kenya

iCMoB 2023-03

Encapsulation of AgNPs in a Lignin Isocyanate Film: Characterization and Antimicrobial Properties

Edwin S. Madivoli, Sammy I. Wanakai, Pius K. Kairigo, Rechab S. Odhiambo

Abstract

Lignin isolated from agricultural residues is a promising alternative for petroleum-based polymers as feedstocks in development of antimicrobial materials. A polymer blend based on silver nanoparticles and lignin–toluene diisocyanate film (AgNPs–Lg–TDIs) was generated from organosolv lignin and silver nanoparticles (AgNPs). Lignin was isolated from *Parthenium hysterophorus* using acidified methanol and used to synthesize lignin capped silver nanoparticles. Lignin–toluene diisocyanate film (Lg–TDI) was prepared by treating lignin (Lg) with toluene diisocyanate (TDI) followed by solvent casting to form films. Functional groups present and thermal properties of the films were evaluated using Fourier-transform infrared spectrophotometry (FT–IR), thermal gravimetry (TGA), and differential scanning calorimetry (DSC). Scanning electron microscopy (SEM), UV–visible spectrophotometry (UV–Vis), and Powder X-ray diffractometry (XRD) were used to assess the morphology, optical properties, and crystallinity of the films. Embedding AgNPs in the Lg–TDI films increased the thermal stability and the residual ash during thermal analysis, and the presence of powder diffraction peaks at $2\theta = 20, 38, 44, 55,$ and 58° in the films correspond to lignin and silver crystal planes (111). SEM micrographs of the films revealed the presence of AgNPs in the TDI matrix with variable sizes of between 50 to 250 nm. The doped films had a UV radiation cut-off at 400 nm as compared to that of undoped films, but they did not exhibit significant antimicrobial activity against selected microorganisms.

iCMoB 2023-04

Stimuli-Responsive and Antibacterial Cellulose-Chitosan Hydrogels Containing Polydiacetylene Nanosheets.

Edwin Shigwenya Madivoli, Justine Veronique Schwarte, Patrick Gachoki Kareru, Anthony Ngure Gachanja, Katharina M. Fromm

Abstract

Herein, we report a stimuli-responsive hydrogel with inhibitory activity against Escherichia coli prepared by chemical crosslinking of carboxymethyl chitosan (CMCs) and hydroxyethyl cellulose (HEC). The hydrogels were prepared by esterification of chitosan (Cs) with monochloroacetic acid to produce CMCs which were then chemically crosslinked to HEC using citric acid as the crosslinking agent. To impart a stimuli responsiveness property to the hydrogels, polydiacetylene-zinc oxide (PDA-ZnO) nanosheets were synthesized in situ during the crosslinking reaction followed by photopolymerization of the resultant composite. To achieve this, ZnO was anchored on carboxylic groups in 10,12-pentacosadiynoic acid (PCDA) layers to restrict the movement of the alkyl portion of PCDA during crosslinking CMCs and HEC hydrogels. This was followed by irradiating the composite with UV radiation to photopolymerize the PCDA to PDA within the hydrogel matrix so as to impart thermal and pH responsiveness to the hydrogel. From the results obtained, the prepared hydrogel had a pH-dependent swelling capacity as it absorbed more water in acidic media as compared to basic media. The incorporation of PDA-ZnO resulted in a thermochromic composite responsive to pH evidenced by a visible colour transition from pale purple to pale pink. Upon swelling, PDA-ZnO-CMCs-HEC hydrogels had significant inhibitory activity against E. coli

attributed to the slow release of the ZnO nanoparticles as compared to CMCs-HEC hydrogels. In conclusion, the developed hydrogel was found to have stimuli-responsive properties and inhibitory activity against E. coli attributed to zinc nanoparticles.

iCMoB 2023-05
Environmental remediation using nanomaterial as adsorbents for emerging micropollutants
Author links open overlay panel
Dennis Mwanza Nzilu, Edwin Shigwenya Madivoli, David sujee Makhanu, Brian Victor Otenda, Patrick Gachoki Kareru, Pius kinoti Kairigo, Tuula Tuhkanen

Abstract

Water shortage and scarcity are issues of global concern. Water pollution caused by organic micropollutants further aggravates the problem, by rendering an already scarce resource unfit for human consumption. The existing conventional wastewater treatment methods and infrastructure were not designed to eliminate micropollutants. Therefore, their inefficiencies call for modern methods for removing emerging micropollutant residues such as Active Pharmaceutical Ingredients (APIs), Endocrine Disrupting Compounds (EDCs), personal care products and pesticides. The use of nanomaterials, for the abatement of micropollutants in water is gaining traction in recent years, due to the abundance of sustainable, cost-effective raw materials, especially plant extracts. Synthesis of nanoparticles and their application in removal of micropollutants in wastewater streams is addressed through this review.

iCMoB 2023-06
High Swelling Carboxymethyl Cellulose Synthesized from Coconut Fibers
Gichuki Joyline, Kareru Patrick Gachoki, Gachanja Anthony Ngure, Ngamau Catherine Nyambura, &Madivoli Edwin Shigwenya,

Abstract

To attain the zero waste and green chemistry goals, much emphasis has shifted toward the use of cellulose derived from agricultural biomass. In this study, carboxymethylation of microcrystalline cellulose from coconut fiber by use of monochloroacetic acid in the presence of an alcohol medium under alkaline conditions was suitable for the synthesis of carboxymethyl cellulose. The carboxymethyl cellulose was prepared, and the physical properties, degree of substitution, swelling capacity, and characterization were investigated. The results indicated that the yield of carboxymethyl cellulose, degree of substitution, and swelling capacity were 9.45 ± 0.76 g, 1.82 ± 0.12, and 11.23 ± 0.28 g, respectively. The Fourier Transform Infrared spectra of carboxymethyl cellulose displayed a broad OH peak at 3352 cm−1 and a sharp peak at 1600 cm−1 attributed to -COO. Thermal behavior was investigated by Thermal gravimetric analysis, and the phase transition was determined by Differential Scanning Calorimetry, which revealed that alkalization and esterification of cellulose

lead to a decrease in the thermal stability of the polymer. In conclusion, zero waste can be achieved in the coconut industry as it is rich in cellulose that can be converted to carboxymethyl cellulose, which can be utilized to produce emulsifiers and superabsorbent polymers.

1.4. Compilation of Abstracts from iCCATS Subtaskforce

iCCATS 2024-01

Gated recurrent unit predictor model-based adaptive differential pulse code modulation speech decoder

GK Sheferaw, W Mwangi, M Kimwele, A Mamuye

Abstract

Speech coding is a method to reduce the amount of data needs to represent speech signals by exploiting the statistical properties of the speech signal. Recently, in the speech coding process, a neural network prediction model has gained attention as the reconstruction process of a nonlinear and nonstationary speech signal. This study proposes a novel approach to improve speech coding performance by using a gated recurrent unit (GRU)-based adaptive differential pulse code modulation (ADPCM) system. This GRU predictor model is trained using a data set of speech samples from the DARPA TIMIT Acoustic-Phonetic Continuous Speech Corpus actual sample and the ADPCM fixed-predictor output speech sample. Our contribution lies in the development of an algorithm for training the GRU predictive model that can improve its performance in speech coding prediction and a new offline trained predictive model for speech decoder. The results indicate that the proposed system significantly improves the accuracy of speech prediction, demonstrating its potential for speech prediction applications. Overall, this work presents a unique application of the GRU predictive model with ADPCM decoding in speech signal compression, providing a promising approach for future research in this field.

iCCATS 2023-01

Enhancing EEG signals classification using LSTM-CNN architecture

Swaleh M. Omar, Michael Kimwele, Akeem Olowolayemo, Dennis M. Kaburu

Abstract

Epilepsy is a disorder that interferes with regular brain activity and can occasionally cause seizures, odd sensations, and momentary unconsciousness. Epilepsy is frequently diagnosed using electroencephalograph (EEG) records, although conventional analysis is subjective and prone to error. The dynamic and non-stationary nature of EEG structure restricted the performance of Deep Learning (DL) approaches used in earlier work to improve EEG classification. Our multi-channel EEG classification model, dubbed LConvNet in this paper, combines Convolutional Neural Networks (CNN) for extracting spatial features and Long Short-Term Memory (LSTM) for identifying temporal dependencies. To discriminate between epileptic and healthy EEG signals, the model is trained using open-source secondary EEG data from Temple University Hospital (TUH). Our model outperformed other EEG classification models employed in comparable tasks, such as EEGNet, DeepConvNet, and ShallowConvNet, which had accuracy rates of 86%, 96%, and 78%, respectively. Our model attained

an amazing accuracy rate of 97%. During additional testing, our model also displayed excellent performance in trainability, scalability, and parameter efficiency.

iCCATS 2023-02

Waveform based speech coding using nonlinear predictive techniques: a systematic review

Gebremichael Kibret Sheferaw, Waweru Mwangi, Michael Kimwele & Adane Mamuye

Abstract

Speech coding is a technique that compresses speech signals into a smaller digital form, making it easier to transmit or store, while still maintaining the quality and intelligibility of the speech. The review aimed to identify and analyses the most effective waveform-based nonlinear speech coding prediction techniques, including the use of neural networks and polynomial filters. The study analyzed 29 publications from 2000 to 2023 and found that neural network-based models are widely used for speech compression, with RNN topologies being favored due to their ability to introduce nonlinearity and nonstationary. While nonlinear adaptive speech prediction techniques have been explored for speech coding, further research is needed to optimize the adaptive algorithms used in these models. The review also identified a need for future research to address quality performance and computational cost, and suggested further exploration of RNN predictor models. The methodology used in this study involved a computer science approach that follows three main phases: planning, conducting, and reporting. Six different stages were followed, including determining research questions, defining research approach, study selection criteria, quality measurement criteria, data extraction strategy, and synthesizing extracted data. Overall, this study highlights the need for continued research in the development and improvement of neural network-based speech compression models.

iCCATS 2023-03

Improved transfer learning using textural features conflation and dynamically fine-tuned layers

Raphael Ngigi Wanjiku1, Lawrence Nderu2, Michael Kimwele

Abstract

Transfer learning involves using previously learnt knowledge of a model task in addressing another task. However, this process works well when the tasks are closely related. It is, therefore, important to select data points that are closely relevant to the previous task and fine-tune the suitable pre-trained model's layers for effective transfer. This work utilises the least divergent textural features of the target datasets and pre-trained model's layers, minimising the lost knowledge during the transfer learning process. This study extends previous works on selecting data points with good textural features and dynamically selected layers using divergence measures by combining them into one model pipeline. Five pre-trained models are used: ResNet50, DenseNet169, InceptionV3, VGG16 and MobileNetV2 on nine datasets: CIFAR-10, CIFAR-100, MNIST, Fashion-MNIST, Stanford Dogs, Caltech 256, ISIC 2016, ChestX-ray8 and MIT Indoor Scenes. Experimental results show that data points with lower textural feature divergence and layers with more positive weights give better accuracy than other data points and layers. The data points with lower divergence give an average improvement of 3.54% to 6.75%, while the layers improve by 2.42% to 13.04% for the CIFAR-100

dataset. Combining the two methods gives an extra accuracy improvement of 1.56%. This combined approach shows that data points with lower divergence from the source dataset samples can lead to a better adaptation for the target task. The results also demonstrate that selecting layers with more positive weights reduces instances of trial and error in selecting fine-tuning layers for pre-trained models.

iCCATS 2023-04

Artificial Intelligence-Based Chatbot Model Providing Expert Advice to Potato Farmers in Kenya

Meshack Korir, Waweru Mwangi, Michael Kimwele

Abstract:
This research paper presents a solution to the declining yield in potato farming in Kenya, which has been attributed to a limited supply of quality seeds and access to expert advice. The study used IBM Watson Assistant, an AI-based chatbot framework, and GIS to offer expert advice and link farmers to quality seed producers. The paper first introduces potato farming in Kenya and provides a brief history of conversation agents before delving into the theory behind chatbots, including their classifications and general architecture. The methodology section outlines the five significant steps taken in the research, including data collection, implementation, testing and training, and evaluation. The evaluation phase used performance indicators which are presented in detail. The results demonstrate that this potato farming chatbot model had a score of 97.7% in terms of message coverage, a score of 78.4% in terms of conversation containment, and was 88.05% effective, users were 60% satisfied with the model and the likelihood of use of the model in the future was at 80%. The study concludes that this integrated potato farming chatbot model is a practical solution for farmers to improve their yield, and the recommendations made based on user feedback and expert input could improve the model further. Overall, the study presents a promising location-based approach to addressing food security challenges in Kenya through technology-driven solutions.

iCCATS 2023-05

An Ngram-Based Approach to Determine Trends and Patterns in the Social Networks

Constance Mukina Ngila; Waweru Mwangi; Michael Kimwele

Abstract:
The recent progress in computing has made it easier to collect and store huge amounts of information in a text. The growing size of text datasets in text mining and the high dimensionality associated with knowledge discovery is a great challenge that makes it difficult to classify documents into various categories and sub- categories. This paper focuses on how text can be mined from social networks and then categorized using n-grams to determine specific trends and patterns. The main aim of Knowledge Discovery is to extract knowledge from data in the context of large databases. The volume of information that is available is increasing every day. This data ranges from that used in business transactions to scientific data, sensor data, pictures, videos, etc. There is, therefore, a need for a system capable of extracting the core of available information and automatically generating reports, opinions, or summaries of data to aid organizations in better decision-making. Knowledge Discovery is a

repetitive process where evaluation measures are often enhanced, mining done on data can be refined, there is an integration of new data, and the data is transformed to get accurate and more appropriate results. The data collected from social networks need to be filtered to capture specific text that will be useful to a PR brand following what clients say about their products online. There is a need for a technique that will provide a quick and precise way of fetching specific text from huge amounts of data on social networks to help analyze the feedback. This research analyzes the use of n-grams to fetch specific text from near-real-time customer feedback that is in the form of large data on Twitter to help Public Relations agencies determine the trends and patterns that will help them align their brands with customer preferences.

iCCATS 2023-06
Comparing Deep Learning Object Detection Methods for Real Time Cow Detection
GW Martha, RW Mwangi, S Aramvith, R Rimiru
2023 IEEE Region 10 Conference (TENCON), 2023,

Abstract

Deep learning algorithms particularly Convolutional Neural Networks (CNNs) are the state-of-the-art techniques for object detection, classification, segmentation and behaviour classification. These algorithms have extensive application across various domains including agriculture. However, cow identification in dairy farming still relies on methods like direct visual monitoring which are time consuming, costly and inaccurate; or use of invasive contact devices such as sensors which can cause discomfort during attachment or removal. This research compared three deep learning object detection models i.e. YOLOv5, YOLOv7 and YOLOv8, which were selected based on their performance in object detection tasks. We generated cow images from videos captured from a housed dairy cattle barn. The dataset had 11,828 cow images, augmented to depict different illumination conditions and using makesense AI tool, we annotated the images in YOLO format, trained and validated the three models to visualize cow bounding boxes. Our approach demonstrates efficiency of the YOLOv8 model, achieving an accuracy of 94.7% and 93 % before and after data augmentation respectively. YOLOv8 baseline model was finetuned using the Ray Tune library achieving a mAP@O.50 score of 92. 9%. This research makes a significant contribution in the future research direction of the YOLO algorithm and highlights the practical implementation of deep learning models for cow detection, applicable in livestock management.